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RUINS STABILIZATION REPORT
TECHNICAL SERIES NO. 25

HISTORICAL DOCUMENTATION
AND STRUCTURAL STABILIZATION
OF THE MAIN FERRY SITE
LEE'S FERRY NATIONAL HISTORIC DISTRICT
GLEN CANYON NATIONAL RECREATION AREA
NORTHEASTERN ARIZONA

by

Susan Eininger
Jonathon C. Horn

Under the Direction of

Paul R. Nickens, Ph.D.
Principal Investigator
and

Todd R. Metzger
Project Director
Nickens and Associates
P.O. Box 727
Montrose, Colorado 81402
(303) 249-3411

Prepared for

National Park Service
Rocky Mountain Regional Office
P.O. Box 25287
Denver, Colorado 80225

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ABSTRACT

This report documents the work conducted in October 1985 at the Main Ferry Site of Lee's Ferry National Historic District, Glen Canyon National Recreation Area, northeastern Arizona. The work was completed under the Year 3 provisions of a multiyear ruins stabilization contract between the National Park Service, Rocky Mountain Region, and Nickens and Associates of Montrose, Colorado. The project tasks performed were completed according to the guidelines established by the Statement of Work for Modification No. 4, Contract CX-1200-3-A074.

Site recordation, stabilization, and historical research were conducted at the Main Ferry Site of Lee's Ferry. Fifteen structures and eleven features were identified. Surface artifacts were inventoried, and diagnostics were collected for historical analysis. Six structures were stabilized, the five that were singled out in the statement of work and the sixth identified during recordation of the site. These structures were thoroughly documented; their description, condition, factors affecting their deterioration, and the stabilization activities that took place are included in this report. The historical research findings concerning the Main Ferry Site provide temporal and functional analyses of the structures and artifacts and discuss their relationship to the Lee's Ferry operations as a whole. It is concluded that the Main Ferry Crossing, which has generally been assumed to be the Original or Upper Ferry Crossing established in 1873, was not in use prior to 1898. These findings are based on the information derived from pertinent literature, historical photographs, artifactual analysis, and on-site inspection. Recommendations for future stabilization activities at the Main Ferry Site are included within the report. Recommendations are also given for future historical research activities where additional work might be beneficial.

ACKNOWLEDGMENTS

Special thanks are due to several individuals for their assistance in the successful completion of this project. Park Ranger Jon Dick at Lee's Ferry National Recreation District was very helpful with logistical arrangements and in the gathering of historical data from the National Park Service files. We would also like to thank the Special Collections Library at Northern Arizona University for the use of two historical photos used in the text from their photograph collection and George Cattnach of the NPS Western Archaeological and Conservation Center, Tucson for making arrangements for the duplication of one of those photographs. Permission to copy and use the photograph of Structure 2 from Publisher's Place, Inc. of St. George, Utah is also greatly appreciated.

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CHAPTER 1

INTRODUCTION

The Main Ferry Site of Lee's Ferry National Historic District was documented and stabilized by Nickens and Associates of Montrose, Colorado in October 1985. The work was completed under the Year 3 provisions of a multiyear ruins stabilization contract for Glen Canyon National Recreation Area (GLCA) issued by the National Park Service (NPS), Rocky Mountain Region. The project tasks performed were based on the specifications of the Statement of Work, Modification No. 4, Contract CX-1200-3-A074 and on guidelines established during an on-site prefield meeting with NPS personnel on September 18-19, 1985.

General Background

The Main Ferry Site, as part of Lee's Ferry, is listed on the National Register of Historic Places as an Historic District. Despite its importance historically, very little research or documentation has been conducted at the Main Ferry Site itself. Future plans for interpretive and recreational development of this historic site have brought this deficiency into the forefront.

As a result of this project, the site area was thoroughly documented; all structures, features, and artifacts on the site were located, mapped, and described, and research into their relationship with the 1898-1928 period of ferry operation was conducted.

Structural remains at the Main Ferry Site vary from rubble alignments and leveled areas to partly intact walls. The five structures represented by standing masonry were slated for stabilization work, as their exposed location to the impacts of weathering and visitor use is contributing to further deterioration. Two of the structures (Structures 1 and 2) had been previously stabilized by NPS personnel, possibly in the late 1960s; however, no documentation of this work was ever completed.

As part of the recent stabilization effort, all previous stabilization mortar was removed and replaced with amended mortar that was visually and physically compatible with the original historic mortar. Structural repairs were made along deteriorated portions of the walls; weak points were corrected, and preventative measures were taken in areas that were potentially threatening to the structures' future stability. Most of this work involved repointing, wedging, and newlaying activities; all work was aimed at securing the existing stonework, protecting the remaining mortar, and creating structurally sound walls. Backfilling with sediment and stone to buffer the impacts of foot traffic and exposure was also completed at several of the structures.

During the Year 3 work, the extent of alteration caused by the previous stabilization became apparent at both Structures 1 and 2. New walls constructed by the earlier stabilizers were definitely identified at Structure 2. Rather than stabilize this nonhistoric component of the

structure, it was decided, with the approval of NPS personnel, to dismantle the previous work. The ultimate goal of the project was based not only on creating a stable site, but insuring the preservation of the historical setting of the early ferry crossing. Despite the previous alterations of Structures 1 and 2 and the less than intact nature of the other structures, all materials and techniques utilized in the stabilization work were applied in such a manner as to maintain the architectural and historic integrity of the site.

A total of 13 workdays, October 21 through November 2, 1985, was required for completion of the documentation and stabilization work at the Main Ferry Site. This included two travel days, to and from Lee's Ferry, and involved a crew of varying size. The core work crew, consisting of Susan M. Chandler, Susan Eininger, Donna K. Graves, Jonathon C. Horn, Nancy B. Lamm, and Janet L. McVickar worked a total of 8½ days at the site. Eininger served as field supervisor. Other Nickens and Associates' stabilization personnel, Jim Firor, Joan K. Gaunt, Todd R. Metzger, and Saxon Sharpe, visited the site and contributed ½ day's labor to the project. Todd R. Metzger, project director, visited the site a total of three times during the project duration, providing consultation and direction. Horn, the project historian, utilized one of the field days to conduct a literature search in Flagstaff. Horn and Eininger remained at Lee's Ferry an additional two days to perform final clean up and documentation and to oversee the curing and caliche removal during the mortar drying process.

Location

The Main Ferry Site of Lee's Ferry is in the extreme southwest tip of the Glen Canyon National Recreation Area in Coconino County, northern Arizona (Figure 1). Located on the right or northwest bank of the Colorado River, it is accessed by an undeveloped foot trail that runs upstream from the current boat launch area, past the historic Lee's Ferry Fort, Post Office, and U.S. Geological Survey (USGS) buildings (Figure 2). About 15 miles farther upstream from the site is the Glen Canyon Dam. More specific locational data for the site are outlined in Table 1, below.

TABLE 1. LOCATION OF MAIN FERRY SITE OF LEE'S FERRY

Legal Description:	SW¼ NW¼ SE¼ and NW¼ SW¼ SE¼ Section 18, Township 40 North, Range 7 East
UTM Coordinates:	Zone 12 448075 Easting 4079075 Northing
Elevation:	3200 ft (975 m)
USGS Map Reference:	Lee's Ferry, Arizona 15' (1954)

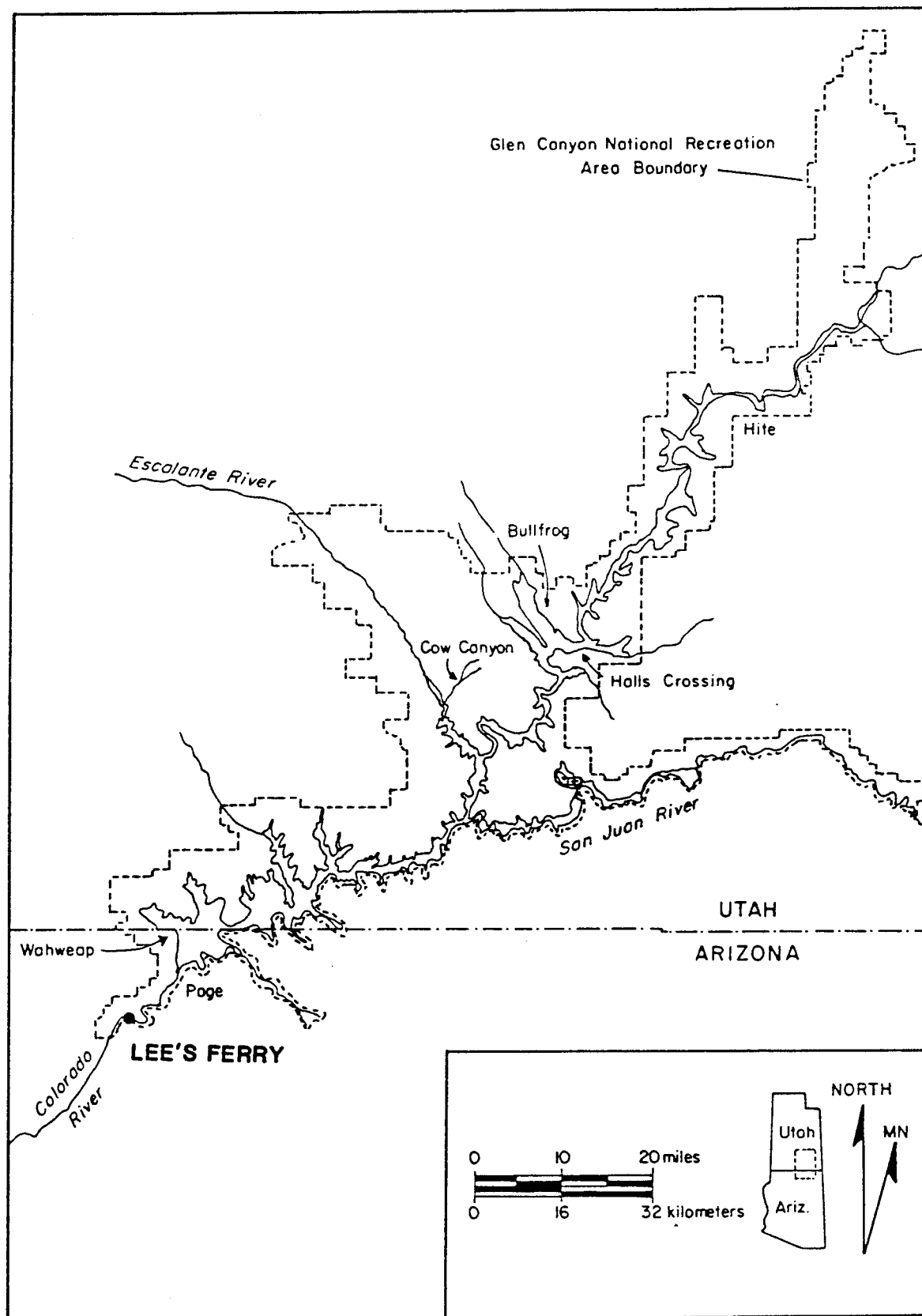


Figure 1. Map of Glen Canyon National Recreation Area showing the location of Lee's Ferry.

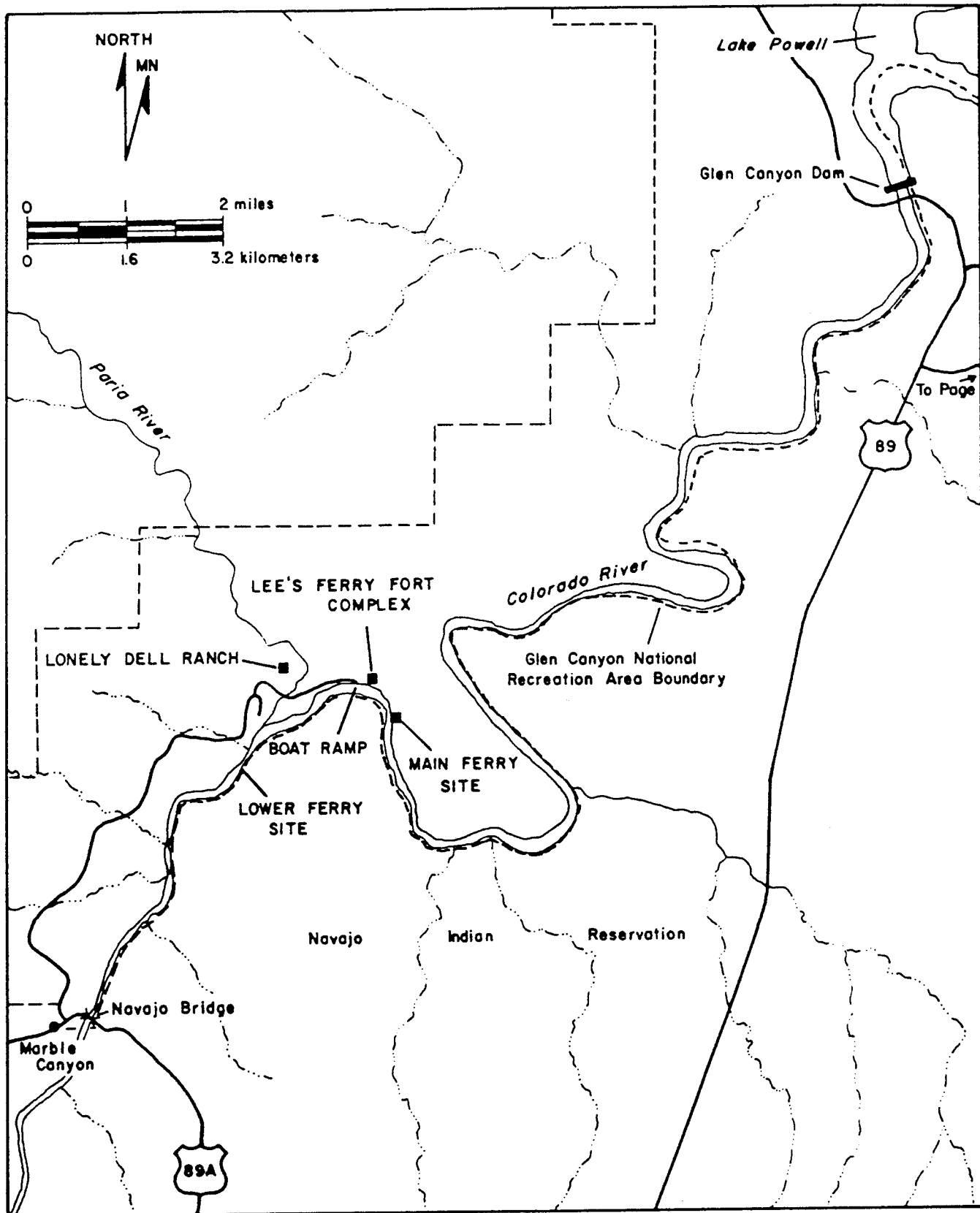


Figure 2. Map of Lee's Ferry showing the location of the Main Ferry Site.

Environment

Lee's Ferry, at an elevation of 3200 ft, is the dividing point between the upper and lower basins of the Colorado River (Crampton 1960) and marks the 0 mile post between them. Here the valley opens up for just over a mile between the cliff walls of Glen Canyon upstream and those of Marble and the Grand Canyon downstream. Impenetrable canyon walls preclude reasonable access to the river for hundreds of miles in either direction. In historic times, Hite, Utah, 300 miles upstream, and Pierce Ferry, Arizona, 282 miles downstream, provided the closest major crossings of the Colorado River other than the Lee's Ferry Crossing. The Paria River empties into the Colorado River roughly 1.4 miles downstream of the site. About 3.3 miles downstream from this confluence is Navajo Bridge, which replaced the ferry crossing in 1929.

To the west and south of Lee's Ferry are the Marble Platform and the larger Paria Plateau faced by the spectacular Vermilion Cliffs. Cutting southwest across the river are the Echo Cliffs marking the end of Glen Canyon. The Kaibito Plateau and the Navajo Indian Reservation lie to the south and east of the river.

The strata of the Triassic Kayenta, Navajo, and Moenave sandstone formations lay horizontally down through Glen Canyon. At Lee's Ferry, these layers are forced abruptly upward to the west and along the monoclinical Echo Cliffs; the lower third of the escarpment is formed by the Moenave and Kayenta formations and the upper two-thirds by the Navajo formation (Baars 1983; Stevens 1983). As these formations eroded back from the river corridor, the older softer shales of the Moenkopi and Chinle formations became exposed, forming the open, more gently sloped valley that characterizes Lee's Ferry, making it accessible as a crossing. Just downstream, the more resistant Permian Kaibab and Toroweap limestones and the Coconino sandstone become exposed at river level, once again forming sheer vertical walls and a narrow, inaccessible canyon (Haynes and Hackman 1978).

The climate of Lee's Ferry is arid, variable, and frequently extreme, with recorded temperatures (1979-1983) ranging from over 104°F down to an uncommon 26°F, with a mean annual temperature of 64°F (U.S. Department of Interior 1984). Though the average annual precipitation is 5.8 inches, as much as 2.69 inches was recorded in August 1951 from one storm alone (Stevens 1983). Generally, the temperatures are high in the summer months and moderate for the remainder of the year, with occasional Pacific winter storms and periods of low pressure occurring in the late fall and winter months (Stevens 1983). The majority of the precipitation falls in the form of violent late summer thunderstorms.

Wind blows in a southwesterly direction and, due to the extreme solar heating of the canyon walls, the rising hot air can often cause fierce upstream winds. Due to this solar heating and subsequent release of heat, a low level of humidity is maintained despite the continual evaporation of the river surface (Stevens 1983).

The arid, Lower Sonoran life zone found at Lee's Ferry supports two quite diverse biological communities, a Riparian Woodland community

characterized by the growth of tamarisk, cottonwood, and willow, and the Mohave Desert Scrub community, found on the dry talus slopes and characterized by four-wing saltbrush, shadscale, creosote bush, yucca, Mormon tea, prickly pear, cholla and other cacti, and a few grasses. Though little faunal life was observed, the presence of the raccoon, ringtail cat, spotted skunk, pocket mouse, coot, grebe, great blue heron, spotted sandpiper, Lucy's warbler, blue grosbeak, canyon wren, toads, various lizards, and other reptiles have been documented in the area (Whitney 1982).

Historical Background

The history of the development and use of Lee's Ferry has been documented in detail by other writers (Rusho and Crampton 1981; Measeles 1981; Crampton and Rusho 1965; Crampton 1960), so will only be briefly described here.

The first Euro-Americans to visit the site of Lee's Ferry were the members of the Dominguez-Escalante party in 1776. Finding it impossible to ford the Colorado River at this point, the returning explorers continued several miles upstream to the head of Navajo Canyon at the place known as the Crossing of the Fathers, now submerged by Lake Powell. Jacob Hamblin passed through the Lee's Ferry area several times in the late 1850s and early 1860s on his way to the Hopi villages farther south. He unsuccessfully attempted to cross the Colorado at the mouth of the Paria River in 1860, finally succeeding during a subsequent trip in 1864. Crossing again in 1869, Hamblin realized the location's potential as a permanent ferry site, especially in transporting Mormon missionaries and settlers into the interior of Arizona. John D. Lee was approached by Hamblin to establish and run a ferry at the isolated spot. Probably influenced by the need to find a safe haven because of his role in the Mountain Meadows massacre of 1857, Lee agreed, arriving late in 1871.

The first ferryboat was constructed during 1872 and put into use the following year. The location chosen for the original ferry crossing was upstream of the mouth of the Paria River. Because of the difficulty of landing ferries on the left bank during times of low water, a second crossing was located later in 1873 below the Paria River, known as the Lower Ferry. The original ferry crossing subsequently appears to have been known as the Upper Ferry Crossing.

Roads had been constructed to and from both ferry crossings on either side of the river by 1878. These dugways, traversing extremely rugged terrain, were very rough to travel on and needed constant repair. The worst was a section of road over a jagged conglomerate uplift on the left side of the river known as Lee's Backbone. Considered to be the worst stretch on the entire route from Utah to central Arizona, Lee's Backbone was bypassed by a slightly better road in 1888.

With the capture of John D. Lee in 1874 and his subsequent execution three years later, operation of the ferry fell on the shoulders of John's wife, Emma, and Warren M. Johnson. Johnson continued to operate the ferry up until 1895 as an employee of the Mormon Church, which purchased Emma Lee's rights in 1879.

Two ferry crossings were in use until 1898 when a cable was stretched across the river at the Main Ferry Crossing. This made safe passage across the river possible at one location regardless of the level of the water. It has generally been assumed that the Main Ferry Crossing and the Upper Ferry Crossing were one and the same. However, the findings of the recent stabilization project have raised some serious doubts about this assumption. It now appears that the upper landing in use prior to 1898 must have been operated in some other location, most logically the beach area upstream of the Paria River in the vicinity of Lee's Ferry Fort, the same location described as the Original Ferry Crossing.

Although peak use of the ferry itself was probably between 1876 and 1890 by Mormon settlers moving to Arizona and marriage parties traveling to and from the temple at St. George, Utah, there was considerable activity at Lee's Ferry from just prior to the turn of the century into the 1910s, mostly related to gold mining. The Hoskaninni Company of Robert B. Stanton had several mining claims upstream of Lee's Ferry and operated a gold dredge on the river until 1901. The most visible evidence of Stanton's presence is the dugway on the south side of the river. This dugway, leading upstream from the Main Ferry's south landing, was constructed in 1899 to access his upstream claims. From 1910 to 1913, Charles H. Spencer made another attempt at extracting gold from the banks of the Colorado River. In order to power the steam equipment that ran the pumps for his hydraulic system, a steamship, the Charles H. Spencer, was operated to transport coal from a source a few miles upstream. Both the use of the Spencer for coal transport and the mining venture were failures.

Surveying of the Colorado River for a potential damsite began in 1914. From 1921 to 1923, the Southern California Edison Company based themselves at Lee's Ferry while doing damsite studies. A favorable site was found four miles above Lee's Ferry; however, this was discarded in favor of the present site of Hoover Dam. While the Edison Company was at Lee's Ferry, a water gauging station was established. This was maintained and operated by the USGS, resulting in the first permanent entry of the Federal Government at Lee's Ferry. Later, in 1946, the Bureau of Reclamation based a field team at Lee's Ferry for additional damsite studies. This work resulted in the construction of Glen Canyon Dam.

In 1927, work began on a bridge spanning the canyon of the Colorado River just below Lee's Ferry. Men and equipment were hauled back and forth across the river on the ferry until June 1928, when an accident killing two passengers and the operator snapped the cable and sent the ferry into Marble Canyon. Completion of Navajo Bridge the following year made replacement of the ferry unnecessary.

As mentioned above, the Federal Government's involvement at Lee's Ferry began in the early 1920s with the operation of the gauging station by the USGS. In 1963, the NPS began development of Lee's Ferry as a recreation site. Acquisition of the site by the NPS as part of the Glen Canyon Recreation Area took place in 1974. At the Main Ferry Site, two structures, presumably the stabilized Structures 1 and 2, were known to be standing at that time. According to Crampton and Rusho (1965:12),

"The cabins were burned in 1959 by the U.S. Geological Survey for the alleged reason that the agency had neither men nor funds to police the buildings against an increasing number of careless tourists." Similar action was taken nearby at the complex of historic buildings at Lee's Ferry Fort in 1967. At that time the USGS, with NPS assistance, demolished six structures constructed prior to 1913. In 1976, Lee's Ferry was nominated and included in the National Register of Historic Places as a Historic District.

Previous Historical and Archaeological Investigations

Prior to the stabilization work undertaken during this project, no formal documentation of the Main Ferry Site had taken place. Basic historical research on Lee's Ferry in general was initiated in response to planned construction of the Glen Canyon Dam. Two publications (Crampton 1959, 1960) detailing the historic sites in Glen Canyon were produced by the University of Utah. These covered the course of the Colorado River from the mouth of the San Juan River to Lee's Ferry. Because Lee's Ferry was not in danger of inundation by the waters of Lake Powell, consideration of the historic resources there was brief with no actual mention of the physical remains at the Main Ferry Site. In a later manuscript produced for the NPS specifically about the history of Lee's Ferry, Crampton and W.L. Rusho (1965) provided more detailed information about the particular site areas, including the Main Ferry Site. Neither this nor the two subsequent histories of Lee's Ferry, which are the most comprehensive studies to date (Rusho and Crampton 1981; Measeles 1981), provide any information specific to the physical remains at the Main Ferry Site or their function during the operation of the ferry. Fortunately, historic photographs of the Main Ferry Site were included in the latter two volumes, which enabled some verification of structures to be undertaken during our stabilization efforts.

In 1976, Lee's Ferry was included in the National Register of Historic Places, establishing Lee's Ferry Historic District. The nomination form is extremely brief in its descriptions of the components of Lee's Ferry, especially of the Main Ferry Site. Although incomplete, this document verifies the presence of historic structures at that location.

Previous archaeological work at the Main Ferry Site appears to have been restricted to stabilization work on Structures 1 and 2. When this took place has not been ascertained. Work was performed on the Post Office building in the Lee's Ferry Fort building complex in 1967 by Roland Richert and Willie Yazzie of the Southwest Archaeological Center's ruins stabilization crew (Richert 1967). Additional work was carried out at several other buildings at the Lee's Ferry Fort complex, possibly at the same time (U.S. Dept. of the Interior 1968). No mention was made of the Main Ferry Site structures in either of these reports. That the structural remains at the Main Ferry Site were in need of stabilization was last reported in 1974 (Wheaton 1974), perhaps indicating that the work was not undertaken until after that date.

CHAPTER 2

RESEARCH METHODS

Site Documentation

Work was conducted at the Main Ferry Site of Lee's Ferry according to the Statement-of-Work, Modification No. 4 of NPS Contract CX-1200-3-A074. Documentation of the site area included mapping, photography, compiling structure descriptions and conditions, recording features, and inventory and collection of artifacts. Stabilization of the site and the associated methods and documentation will be discussed separately in the Stabilization Methods section of Chapter 4.

The Main Ferry Site was point-mapped using a transit, stadia rod, and 50 m tape (Map 1, in map pocket). Several mapping stations were established, all tying into a permanent USGS survey benchmark at 3147.684 feet, located northeast of Structure 1. The map was oriented to magnetic, rather than true, north. Topographic features and elevational contours were included on the planview. The extent of the area to be mapped had been determined during an on-site prefield work meeting on September 18-19, 1985 with NPS personnel.

The 5 structures slated for stabilization were depicted as were the remains of 10 other structures, 11 features, and the dugway leading into the site from farther downstream. Diagnostic artifacts were also point-mapped. A careful inspection of the site area was undertaken to locate all historic artifacts, as well as other structural remains.

Prestabilization documentation was undertaken at the five structures proposed for stabilization. Standard prestabilization recording methods (Metzger, Eininger, and Gaunt 1985a) using Nickens and Associates' architectural and conditional data sheets were completed. These forms are currently on file at Nickens and Associates, Montrose, Colorado; their information is summarized in the Structure 1 through 5 descriptions in this report.

Historical Research Methods

While work was being carried out at Lee's Ferry, investigations were made in the hopes of locating documentary evidence, both written and photographic, pertinent to the Main Ferry Landing at Lee's Ferry. Records at the NPS Lee's Ferry office were examined and found to contain helpful information about the history of Lee's Ferry and management of the historic buildings since the arrival of the NPS. On October 4, 1985, the Museum of Northern Arizona and Northern Arizona University were visited by Horn, the project historian. Dr. Sara T. Stebbins, Historic Archaeologist at the Museum of Northern Arizona, was contacted and provided assistance in locating information in the facility's library as well as names and address of other possible sources of information. Historic photographs were examined at the Special Collections Library at Northern Arizona University. Numerous periodical articles about Lee's Ferry were also perused. A visit was made to Riordan State Park in

Flagstaff where William Perreault, Historian/Registrar for the State Historic Preservation Office, was contacted. In addition, articles have been obtained on interlibrary loan through the Montrose Public Library. As was anticipated, very little additional information was discovered beyond that found in the two main sources on the subject written by W.L. Rusho and C. Gregory Crampton (1981) and Measeles (1981). However, what new information was obtained has proved critical in our interpretations and conclusions about activities at the Main Ferry Site.

CHAPTER 3

SITE DOCUMENTATION

Site Description

The Main Ferry Site at Lee's Ferry contains the remains of 5 partly intact masonry structures; 10 less distinct structures indicated by rock alignments, depressions, or leveled areas; portions of the old dugway; and 11 features including fire rings, a cable anchor, trash dumps, and rubble mounds (Map 1, in map pocket). The site is located between the high water line of the Colorado River and the base of the steep talus slope and parallels the river for roughly 875 feet. A large sandstone monolith and a nearby drainage mark the southwest end of the site, and Structure 5 marks the northeast end. These boundaries were established by the NPS for management purposes and are not necessarily the true limits.

Structures 1 through 5 are the most prominent remnants of buildings at the Main Ferry Site (Figures 3 and 4). Structures 1 and 2 are rectangular masonry structures, possibly used as temporary housing for travellers. Structures 3 and 4, for the most part dry-laid structures, were most likely used as corrals. Structure 5, at the extreme southeast end of the site, consists of a "dugout"; its function has not been determined. None of these structures have evidence of roofing material, though Structure 2 contains the standing remains of two chimneys.

Due to the presence of abundant amended mortar used during previous stabilization work, it was difficult to ascertain the original construction and mortaring techniques at Structures 1 and 2. Throughout the site, the use of locally acquired sandstone cobbles and blocks, usually fairly large in size, was prevalent. Existing monoliths were frequently incorporated into the wall construction, particularly in Structures 3 and 4. Remnants of other building materials - pieces of window glass, screening, wood remnants, and numerous round nails - were evident sporadically throughout the site. Use of iron strapping and pipe is evident in the chimneys of Structure 2.

Portions of the dugway, which was built to provide access to the ferry site, are still visible along the foot trail to the site along the river (Figure 5). Upon entering the site, the dugway becomes a surface road, which forks in a southerly direction to a sandy, rock-free clearing at the river's edge that was used as the ferry landing. Portions of a system of roads are visible through the site. In places it is difficult to differentiate the historic roadways from the modern foot trail. At the point where the road enters the extreme northwest end of the Main Ferry Site, an historical inscription H K WHITE, AUG 27(?) 1921 is visible along the east face of a large monolith. On the opposite side of this boulder, written in mud, are the names "ROY" and "NANCY." According to Jon Dick (1987: personal communication), these were written by Roy Johnson in about 1897 when he was seven years old. Roy Johnson was the son of Warren Johnson, who operated the ferry for many years.

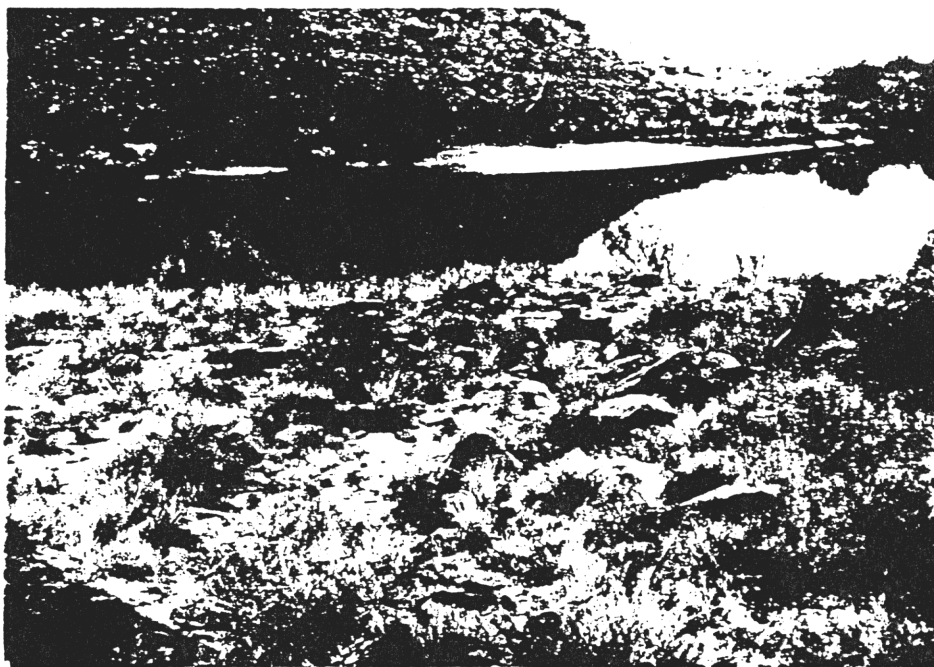


Figure 3. Structures 1 and 2 at the north end of the site.

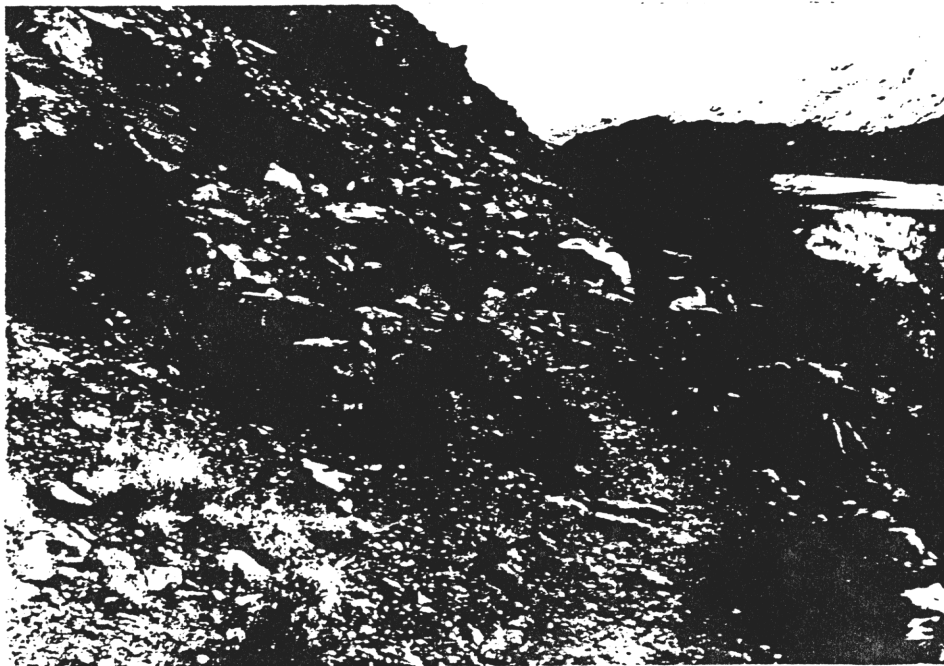


Figure 4. The south end of the site with Structure 4 in the photo center. Structure 5 is behind Structure 4 along the foot trail.

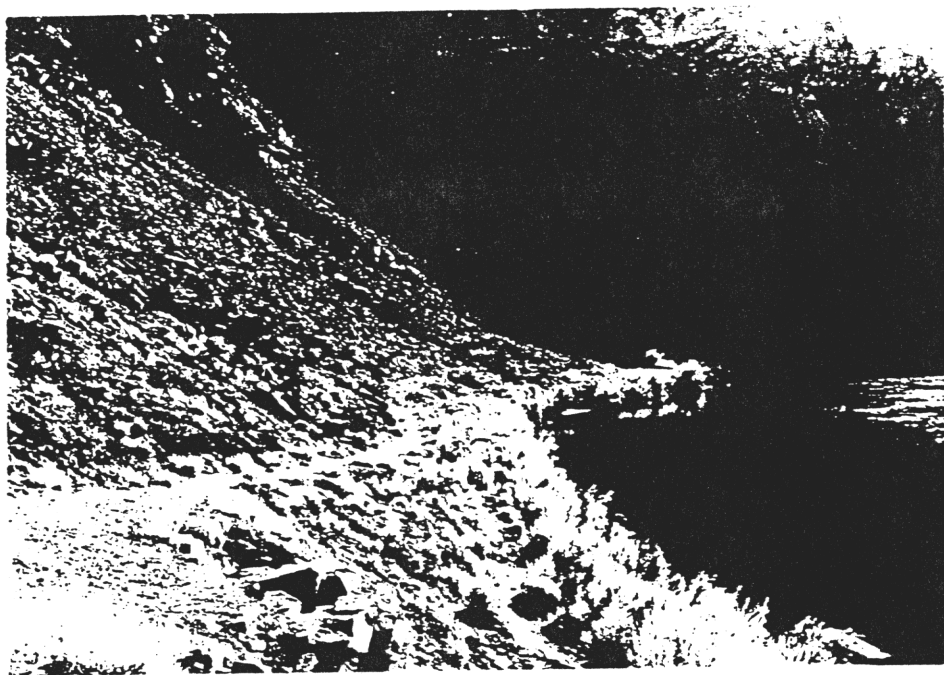


Figure 5. View along the dugway toward the Main Ferry Landing from the beginning of the Spencer Trail. Note the boiler of the steamship Charles H. Spencer in water at lower right.

Numerous surface artifacts were recorded throughout the site, though most were found in association with the three trash dumps or with specific structures. Fragments of vessel glass, numerous nails, car parts, cans of various types, cartridges, iron strap metal fragments, leather fragments, and pieces of wire are among the items observed.

Structure Descriptions

Structure 1

Structure 1 is located toward the north end of the site, along the existing foot trail. It consists of a rectangular masonry room measuring roughly 8 feet northeast-southwest by 9 feet southeast-northwest (Figure 6). The walls are constructed of undressed, sandstone blocks, tabular slabs, and irregular stones of a great variety of sizes and shapes. They are semicoursed, dry-laid/mudded with some wet-laid sections; and double stone, single stone, and double stone/mortar core in cross section. The double stone/mortar core construction predominates with the core consisting of large amounts of mortar and small stones. From two to nine courses are standing, for a maximum height of roughly 3.5 feet (interior) and 4.5 feet (exterior).

Data on joints and mortar were difficult to gather, since perhaps 85% of all joints have been repointed by previous stabilizers. What original mortar remains is fine-textured, with inclusion of small, rounded siltstone pieces and larger, angular quartzite fragments. True and level spalls are present in the horizontal joints, with true chunks and spalls occurring in the vertical joints. These may or may not be original, as they are cemented in place. All the original joints are concave due to erosion.

The exterior walls are tied at all four corners, but the interior east and west walls abut the north and south walls, which were apparently built first. With the exception of the west wall, which has smaller exterior stones, most stones used on the exterior are larger, thus the number of exterior courses is less. Extremely large sandstone blocks are incorporated into the south wall, where the construction varies from single stone to double stone/mortar core, depending on the stone size.

There is a 2 foot 7 inch wide doorway in the center of the south wall indicated by the lower portion of the two jambs. The floor is obscured by post-occupational fill, with bits of charcoal and charcoal-stained soil apparent. The sawn, charred end of a possible roof beam is protruding through the floor fill in the southwest corner of the structure. One 12d or 16d (penny) wire nail was also noted in this area. No roofing remains are present at this structure, although in the southeast and northwest interior corners small remnants of melted black, composite shingle roofing were noted adhering to the wall stones.

Removal of the previous stabilization cement showed that the north, east, and west walls had been heavily reworked when previously stabilized. Mortar beds beneath and behind several courses of stone, particularly in the interior north wall, indicate that many courses were re-

LEE'S FERRY / MAIN FERRY SITE
STRUCTURE 1

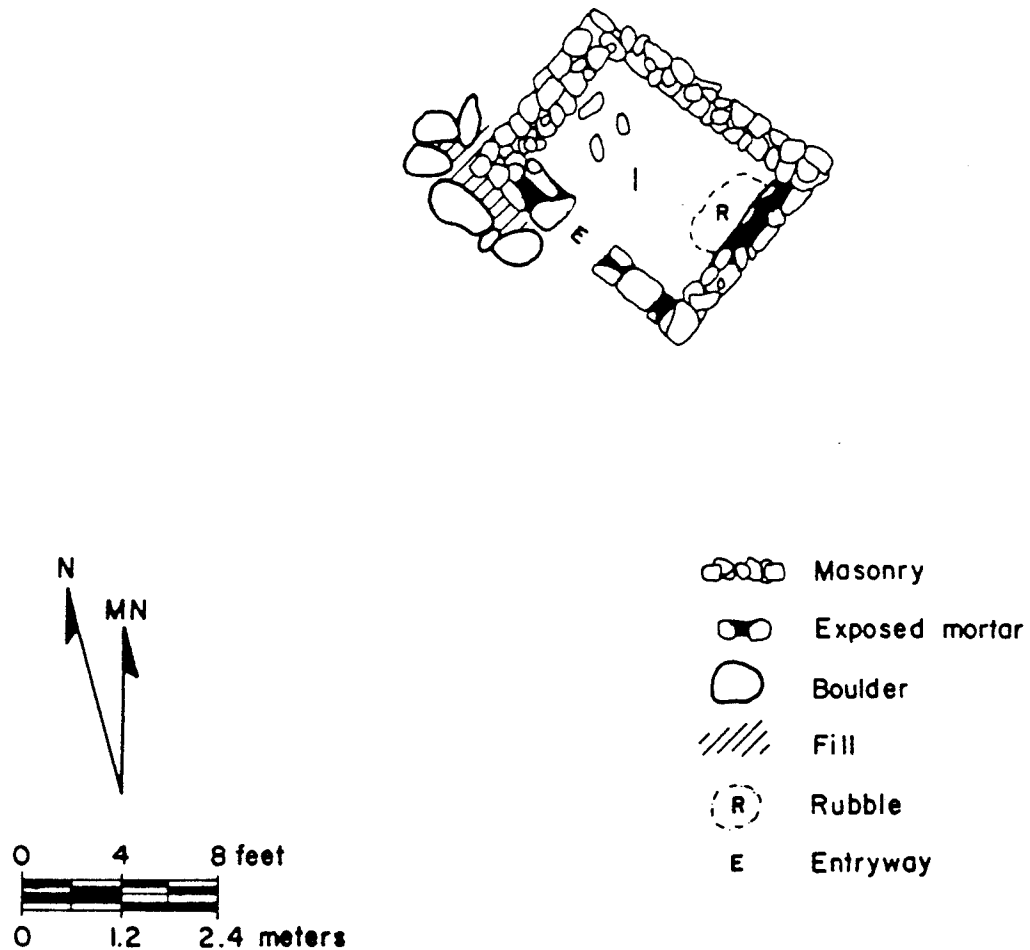


Figure 6. Planview map of Structure 1 at the Main Ferry Site.

laid or newlaid. It was difficult to discern original stonework from the earlier stabilizer's work, due to the heavy amounts of cement used in all the stabilized joints.

Structure 2

Structure 2 is located roughly 72 feet east of Structure 1. It consists of three masonry walls, east, south, and north, outlining the remains of a rectangular structure 25 feet north-south by 16 feet east-west (Figure 7). The east wall consists of two standing fireplaces and associated chimneys; one at the north end of the wall and one at the south end. There are no remains of a masonry wall connecting the two. The north wall and the north end of the west wall are no longer apparent, nor does a rubble alignment exist; however, a foundation outline is visible along the north end of the structure, indicating its approximate location. The standing south and west walls consisted of low masonry remains, one to five courses high. An opening in the west wall with the remains of a charred upright post to one side appeared to have been a possible entryway.

The structure walls are double stone, single stone, and double stone/mortar core in cross section. Most of the stones appear to be dry-laid/mudded; few are wet-laid. Sandstone tabular slabs were used and presently stand 1 to 16 courses high, the highest portions coinciding with the chimney areas. Wall height ranges from less than 1 foot to about 6 feet high. With the exception of a few areas, the original mortar is largely missing or obscured by earlier stabilization mortar. What does remain of the historic mortar is fine to medium-textured with vegetal, sandstone, and quartzite inclusions. With the exception of one area along the south fireplace, the mortar joint surfaces are recessed. Chinking occurs but is sparsely used.

Along the west side of the south fireplace, an abundant amount of mortar covers the chimney face above the fireplace opening. It seems possible that this heavy application of mortar may have been added to support some type of veneer or mantle across the front of the chimney. On either side and paralleling the fireplace opening, there is a narrow vertical recess or niche in the masonry; these could have been associated with a mantle construction. Two metal struts were noted extending across the interior of the fireplace to support the overlying masonry. The north fireplace also contains two metal supports, as well as a metal strip across the outside edge of the fireplace opening.

Directly in front of the north fireplace, there is an alignment of rubble extending across the interior of the structure. The stones appear to have fallen "en masse" and have maintained their relative positions. Judging from the location and distribution of the stones, it seems likely they represent chimney fall. No other interior features or roofing were located.

Numerous artifacts were found in and around Structure 2. These included four cartridges: a .45 Automatic Colt, two .22 Longs, and a 16

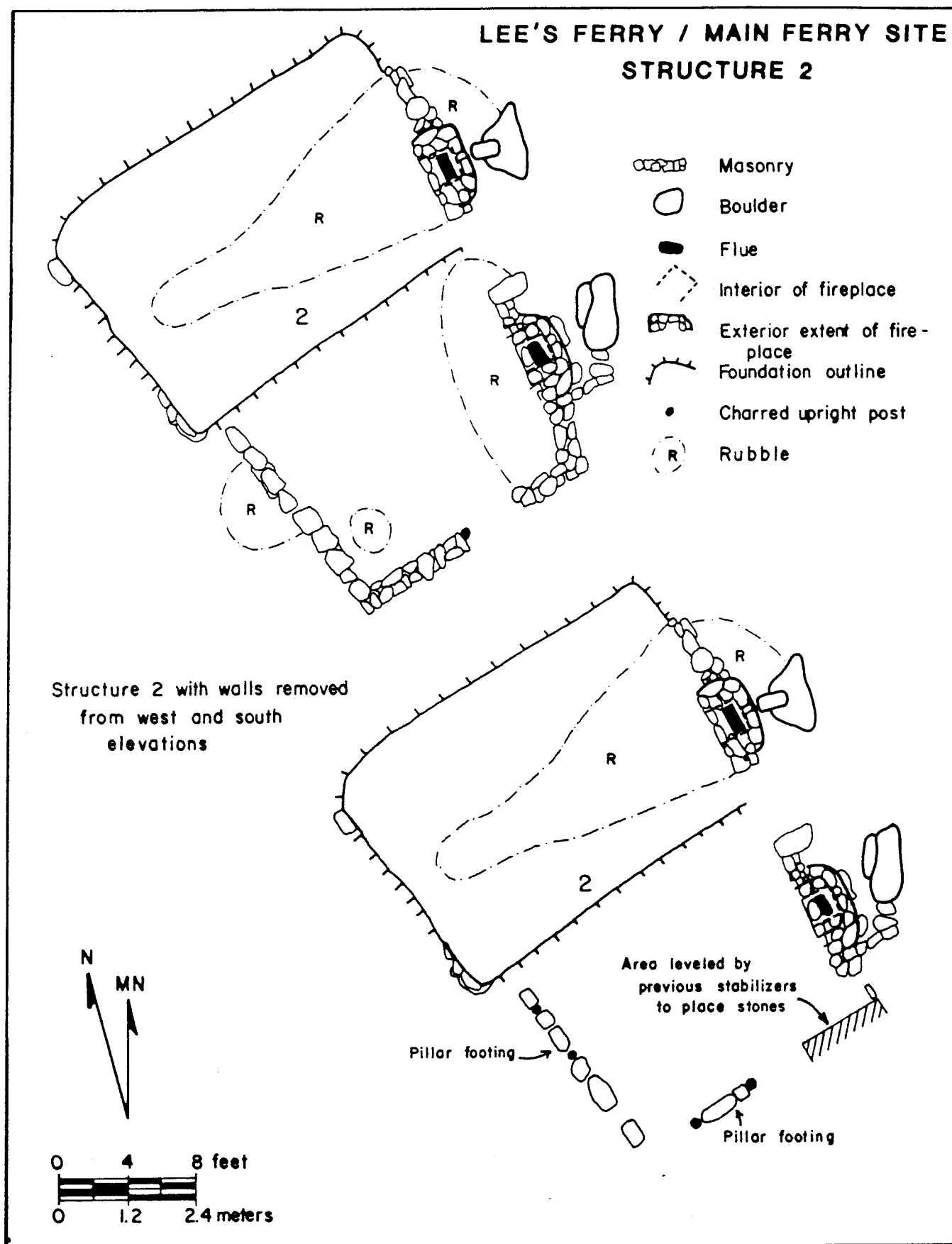


Figure 7. Planview map of Structure 2 at the Main Ferry Site.

gauge Winchester Ranger shotgun shell. Also found were a "Calumet" baking powder lid, a hacksaw blade fragment, numerous wire nails, screen possibly from a window, and clear vessel glass.

In general, the extent of the previous stabilization work prohibits a clear description of the original structure and makes it difficult to discern the historic materials and techniques used at this structure. In examining the construction of the walls, it became apparent that sections of the standing stonework had been altered or completely reconstructed during the earlier stabilization work. The masonry in the southwest and northwest areas of the fireplace appeared to have been added on by the previous stabilizers. These areas were of a different construction style, and the stones were mostly wet-laid within amended mortars. The west wall, south wall, and extreme southern end of the east wall also appeared to be wet-laid within amended mortar. With the mortar beneath and around the stones consisting of amended mortar, the implication was that these walls had been totally rebuilt or reconstructed during stabilization. Examination of the historic photos of this building (Kelly 1943:6; Crampton 1986:131) (Figures 8 and 9) indicates a discrepancy with the present-day remains. The Kelly photo shows the southern half of the structure as an open, roofed porch addition with stone pillars supporting the roof. The photograph in Crampton (1986) probably dating prior to 1943 shows the walls of the addition to be randomly covered by paper and boards. In both photographs, however, it is clear that no solid masonry walls existed. The photos also explain the presence of two fireplaces in one structure; one was within the log cabin and one in the porch addition. During the prestabilization documentation it was noted that the present ground surface of the south half of the structure area was lower than the north half, the difference beginning at the approximate midway point between the two fireplaces. The division of this structure into two rooms would account for this factor as well. A 1925 photograph clearly shows Structure 2 (Measeles 1981:Cover) (Figure 21) with only the cabin on the north half of the structure present. The open air porch addition and second fireplace shown in the 1943 and Crampton photos (1986) apparently had not been constructed at that time. The structure appears to have been a log cabin, eight logs high, with a shallow gable roof. A small window was located in the gable end on the west elevation, while a chimney was set just south of center on the opposite gable end. Based on the photo-documentation, it would appear that the porch addition and fireplace composing the south half of Structure 2 were late additions to the structure, possibly postdating the use of the ferry. The opening in the west wall that was originally interpreted as a possible entry is more likely due to the spacing of the pillars along the west side of the porch addition.

Removal of the stabilization-built walls around the south, west, and southeast portions of the structure verified the original pillar construction (Figure 7). These walls were carefully dismantled in order to determine what was original construction and what had been added during stabilization. The abundance of concrete in the construction made it obvious that the upper courses were not original. Determination of the status of the rockwork composing the basal course was more difficult. What was discovered was that many of the rocks making up the



Figure 8. View of Structure 2 from the southeast taken in 1943. Note the porch addition on the left side of the building apparently constructed of stone pillars. Structure 1 can be seen in the background (Source: Kelly 1943:6).

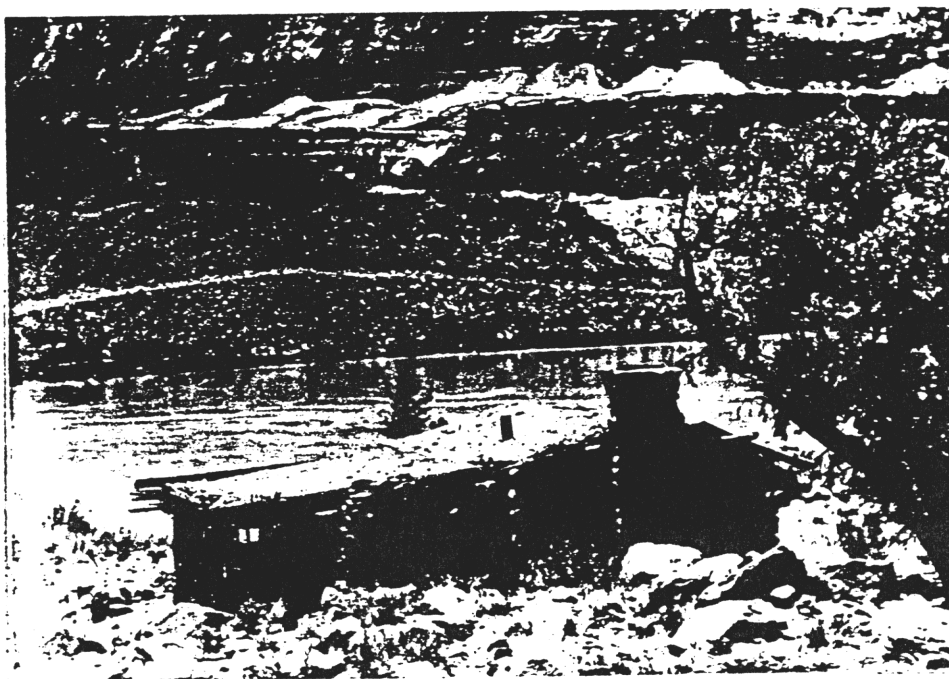


Figure 9. View of Structure 2 from the east, probably taken between 1925 and 1943. Note the log construction of the cabin, earth roof, random coursed stone work adjacent to right of porch addition chimney, and porch wall coverage obscuring stone pillar construction (Source: Crampton 1986:131).

first course had been laid directly upon a layer of charcoal and ash, presumably the result of the razing of the structure in 1959. Those stones that were found resting on native soil were presumed to be from the original structure. This was substantiated by the discovery of the bases of several charred upright posts. These were found flanking pairs of rocks, apparently to lend side support to the columns the paired rocks presumably supported. Two complete arrangements of this sort were exposed, one each on the south and west walls. The 1943 photograph of the patio addition to Structure 2 (Figure 8) shows at least four pillars in the construction. The footings for these were apparently disturbed and obscured during stabilization wall construction. Evidence of this disturbance was most obvious on the east end of the south wall, where the ashy soil from the burned structure was cut through and removed, probably to facilitate the placement of the basal stones for the newly added wall (Figure 10). Further evidence of the incongruous nature of the wall was also found in that location in the form of a .22 Long cartridge and a Calumet baking powder lid below the basal stones. Nickens and Associates' work at Structure 2 has shown that the south, west, and a small part of the east walls, as they existed prior to the 1985 work, were not a true reflection of the original construction of the building. Why these walls were constructed by the previous stabilizers is not known. The pillar footings and abundance of stone in the immediate area from the collapsed pillars may have suggested that walls had been present, leading to the unwarranted work.

Structure 3

Structure 3 is a masonry structure located about 105 feet east of Structure 2. It is oval-shaped, measuring roughly 18 feet north-south by 8 feet east-west (Figure 11). Wall height varies, ranging up to 4.5 feet high. Its construction is primarily dry-laid with the exception of a wet-laid and dry-laid/mudded portion of the south end of the west wall and a wet-laid portion of the basal north wall. The mortar that remains is light red, medium-textured, and has numerous inclusions giving it a coarse appearance. The masonry consists of predominantly large to medium-sized irregular blocks of locally acquired sandstone. These have been laid in an uncoursed manner. Existing monoliths have been incorporated into the walls. The north, east, and south walls are semi-subterranean on the exterior. The south portion of the west wall has collapsed; one to two courses of rubble remain. The interior fill contains scattered charcoal and a few rusted can fragments. No roofing material is apparent, and due to the lack of rubble and type of wall construction, the walls appear to be standing at or close to their original height. The function of this structure is not evident. The original entry to the structure is not apparent, though current entry is gained through the 9 foot wide opening in the west wall. The amount of rubble in this area is fairly small; it is possible that original entry was at this location.

Structure 4

Structure 4 is a corral built upon a steep talus slope located at the southeast end of the site. It is composed of three distinct walls, north, east, and south, which are constructed of dry-laid, uncoursed to semicoursed masonry (Figure 12).

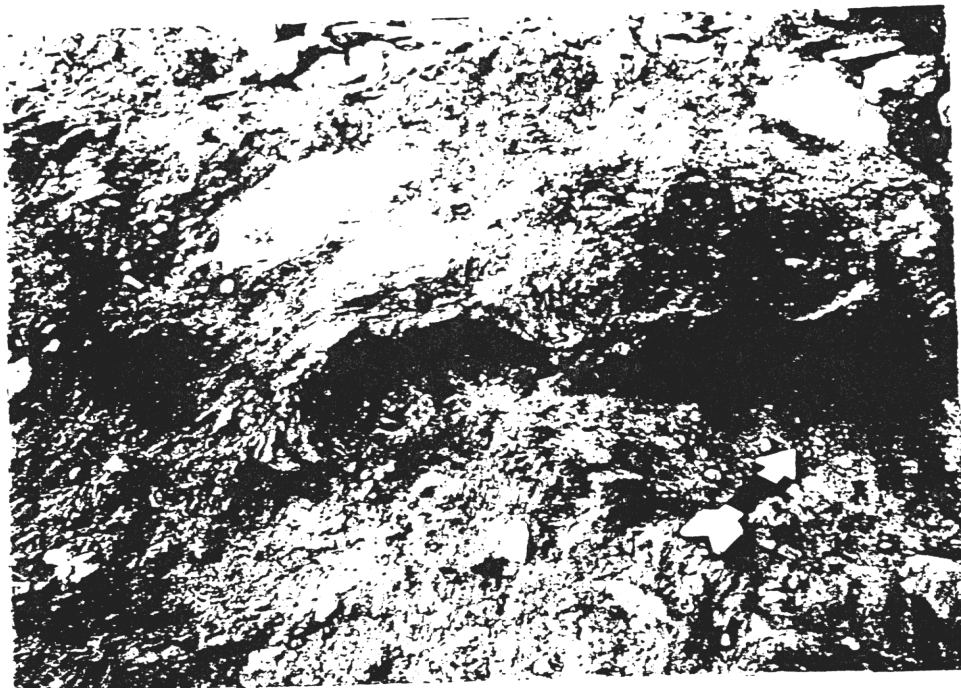


Figure 10. South wall of Structure 2, after removal of intrusive rock wall. Note burned layer (right), probably cut through by previous stabilizers to place rocks, and charred end of upright post (left).

LEE'S FERRY / MAIN FERRY SITE
STRUCTURE 3

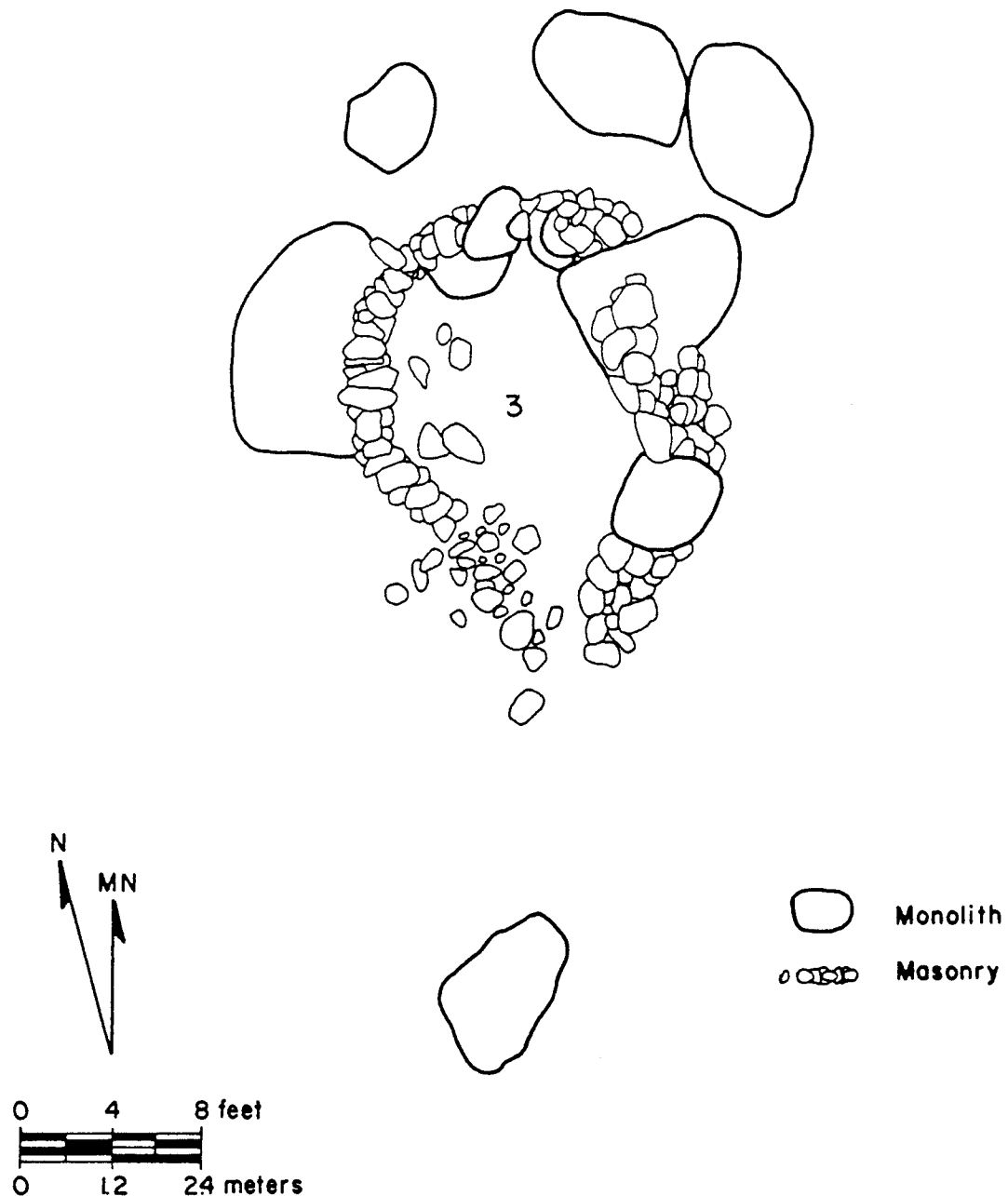


Figure 11. Planview map of Structure 3 at the Main Ferry Site.

LEE'S FERRY / MAIN FERRY SITE STRUCTURE 4

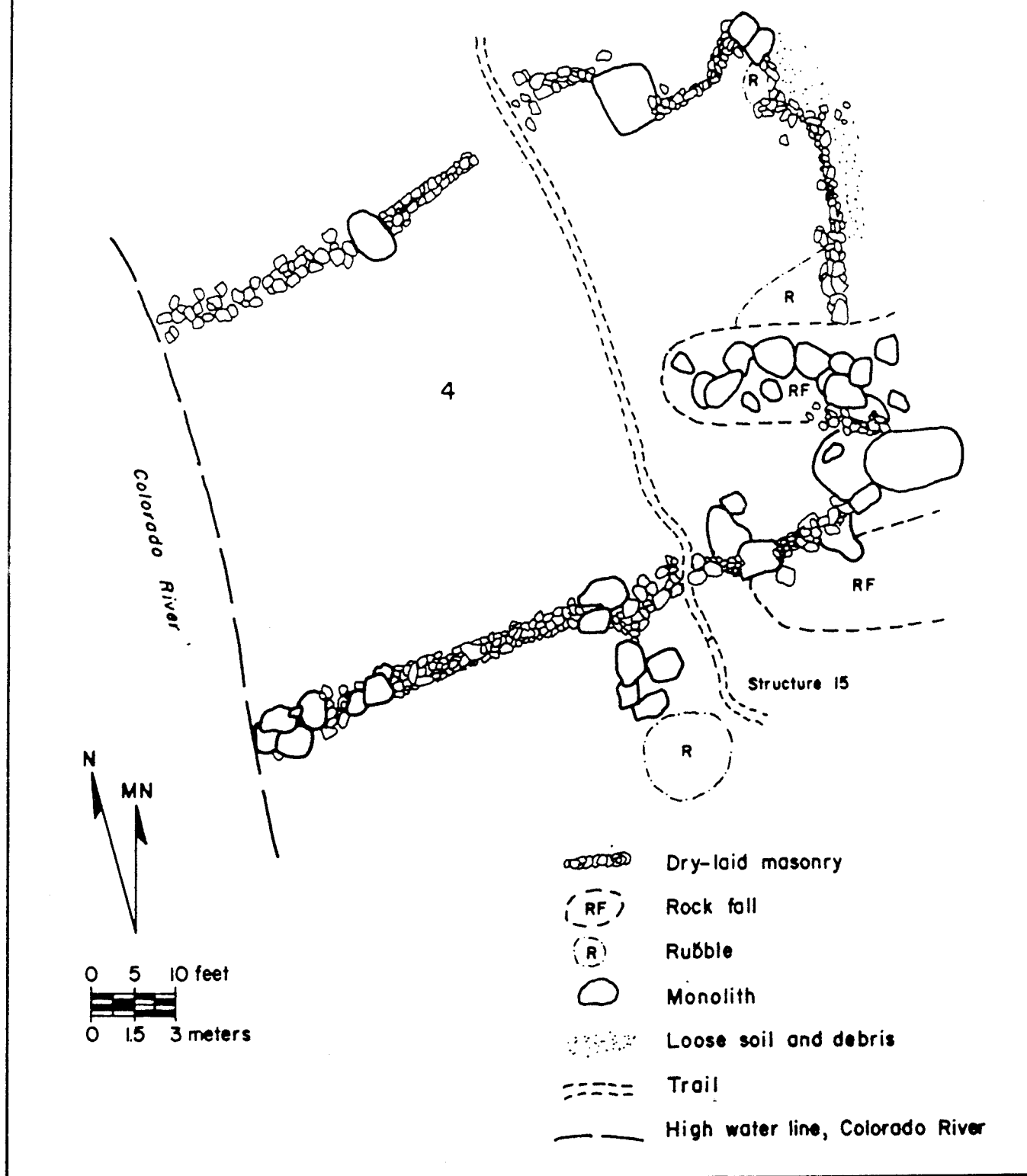


Figure 12. Planview map of Structure 4 at the Main Ferry Site.

The east wall, roughly 62 feet long, consists of an alignment of blocky and tabular stones up to seven courses high. Naturally occurring monoliths were utilized within the wall, with one serving as a corner-stone for the north and east walls. The exterior east wall face is largely subterranean, with fill flush with the top of the wall.

The north and south walls extend downslope to the west about 79 feet, ending at the high water line of the Colorado River. These walls are similar in construction to the east wall; they incorporate existing monoliths in their construction and many of the wall stones have a random, rubble-like appearance. The present-day fishermen's trail cuts across the lower third of the structure through gaps in the south and north walls.

There is no west wall at this structure. The west ends of the north and south walls are fragmented. It has been suggested that this enclosure was built to open into the river, presumably for watering the stock. If this were the case, the south and north walls would have extended farther into the river so as to be functional during low water. It is also possible that a west wall may have existed at one time but has since washed away due to flooding.

Structure 5

Structure 5, known as the "dugout," is located at the extreme south end of the site. The main foot trail leading upriver runs along its west end (Figure 13). The structure is rectangular in shape, excavated into the talus slope. The entire excavated area measures roughly 19.5 feet east-west by 6.5 feet north-south. Its actual dimensions, however, may have been smaller, the excavated area having become enlarged due to erosion and slumping. There is an accumulation of rubble within the structure 8.5 feet to the inside of the excavated area's east end. This rubble, rather than the end of the excavated area, may be the original location of the east wall. There is no way to substantiate this at this time, other than the fact that the north and south masonry walls extend to this point and do not appear in the eastern portion of the excavated area. However, this absence of masonry could also be the result of deterioration.

The width of the masonry-enclosed portion averages 3 feet. The north and south masonry walls appear to have been dry-laid. Fill was noted within many of the joints, however, and could be the remains of deteriorated mortar; the structure's exposed location would account for such extreme deterioration. It is also possible that fill gravitated into the joints from the excavated surface behind the masonry.

The west ends of the north and south walls curve outward, forming the west side of the structure and retaining the upslope fill and talus. The masonry is uncoursed on the north side and semicoursed to uncoursed on the south side; tabular to blocky sandstone was used. No roof exists, nor is there evidence of one. No prepared floor surface was noted. Excavated fill and bedrock sloping up to the east presently cover the interior floor surface.

LEE'S FERRY / MAIN FERRY SITE
STRUCTURE 5

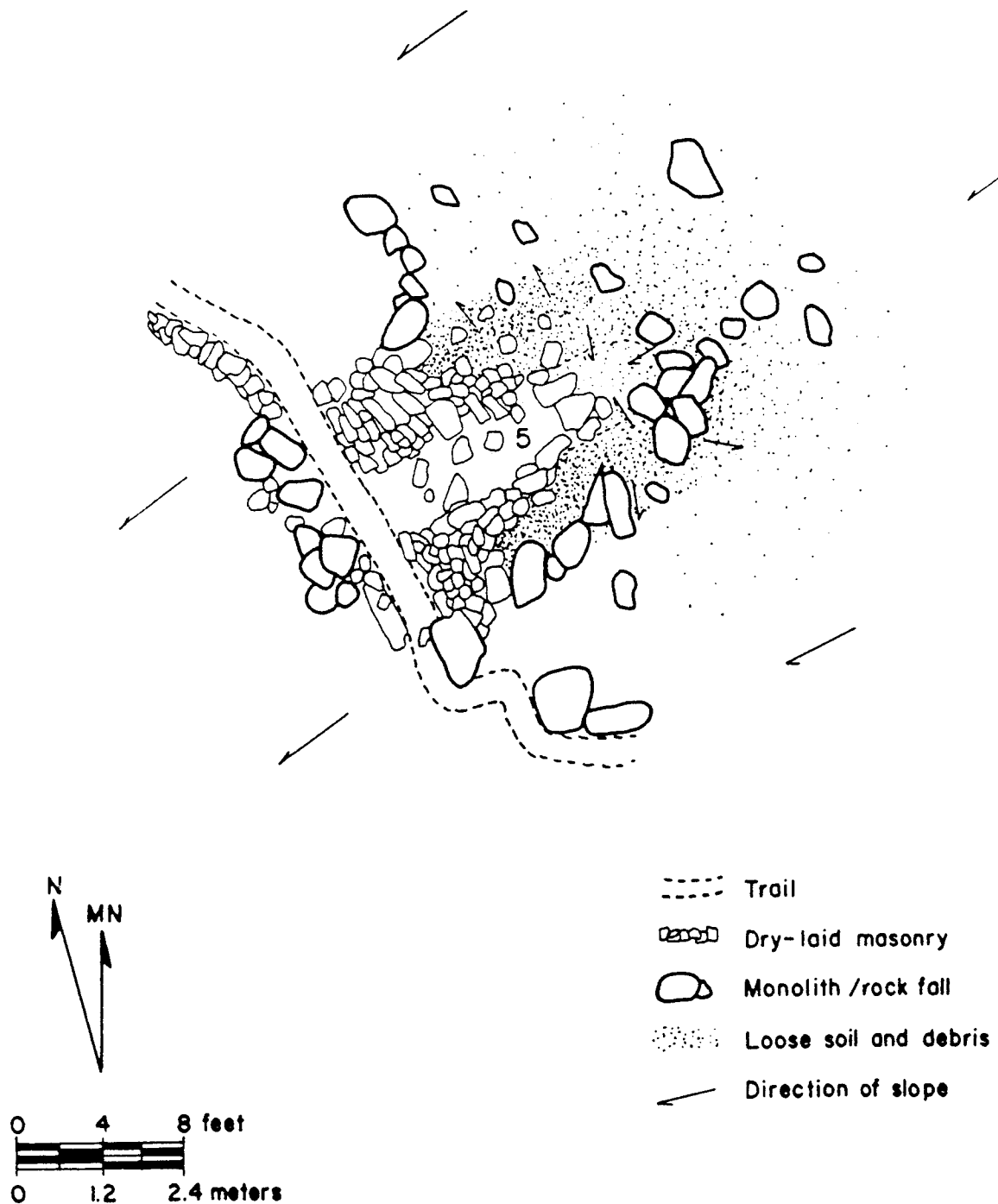


Figure 13. Planview map of Structure 5 at the Main Ferry Site.

It has been suggested that the structure was used to cache explosives, but no evidence of function is now apparent. The trail is located at the west, downslope end of the structure. Rubble that is evident on the far side of the trail may be associated with the structure or the result of trailwork and downslope movement.

Structure 6

Structure 6, located about 12 feet southeast of Structure 1, is a small, square, slightly depressed cleared area outlined on three sides by sandstone cobbles. This area measures roughly 3 feet by 8 feet, set perpendicular to the river. No artifacts were present that might indicate its function; however, its small size and configuration suggest the possibility that this might be the location of an outhouse.

Structure 7

Structure 7 is an irregular leveled area, roughly 10 feet by 15 feet in size, parallel with the river. It appears to be the foundation of a wood frame structure. This structure is perched on the edge of the bench just above the heavily vegetated floodplain of the river at the northwest end of the site. Only one possible foundation corner is visible, on the northwest corner, where unshaped, angular sandstone cobbles meet at right angles. A large number of round nails are present all over the leveled area, ranging in size and number from a single 4d nail to numerous single and duplex 8d nails to a few 16d nails. These indicate that a fairly substantial framework was present. Other artifacts noted in the area include numerous pieces of clear vessel glass, a single piece of purple vessel glass, a chrome D-ring 7/8 inch wide, a .22 Long cartridge marked "US," and a .38 Smith and Wesson cartridge.

Structure 8

Possibly associated with Structure 7 and located about 15 feet to the southwest is Structure 8, a rectangular stone foundation and depression, probably marking the location of an outhouse. The foundation, roughly 4 feet by 6 feet and oriented parallel to the river, is constructed of unshaped, angular sandstone cobbles two courses wide. The soil within the foundation has settled to a level about 1 foot below the surrounding area, revealing at least two courses of masonry in the construction.

Structure 9

About 20 feet northeast of Structure 1 is Structure 9, a leveled area on which partial rock alignments are visible, possibly delineating a structure location. This structure appears to have measured roughly 10 feet by 14 feet, oriented parallel to the river. The rock alignments form what would have been the southeast corner and portions of the south and west sides of the structure. Some filling on the downhill side appears to have taken place using sandstone rocks in order to form a flat platform. A rock alignment projects away from the southwest corner of the possible structure at about a 45° angle. Whether this is just fortuitous or actually man-made could not be determined. Artifacts in

the vicinity consist of modern style food cans, small hole-in-cap lead sealed square cans, small leather fragments, and a piece of strap iron with two holes drilled through it.

Structure 10

Structure 10, east of Structure 9 about 14 feet, is a rock outline of what may have been a small building, possibly a storage structure or an outhouse. This outline measures 5 feet by 6 feet, set perpendicular to the river. The structure area has been leveled into the hillside with sandstone cobbles lining the resulting slight depression, leaving the southwest end open. No artifacts are present within the structure outline. However, just to the south is a thin piece of strap iron with nails through it, probably used to reinforce a wooden box.

Structure 11

Structure 11 is a leveled area about 70 feet south of Structure 1 overlooking the ferry landing area. It appears to be the foundation of the log cribwork over which the main cable passed. This structure is shown in the historic photos of the ferry operation (Figures 14, 15, and 22). The dimensions of the foundation are 15 feet by 21 feet; it is oriented parallel to the river. It was built out toward the river from the surrounding hillside, resulting in a 4.5 foot high retaining wall being present on the southwest elevation.

Very few artifacts are in evidence on the leveled area. Those present include a fragment of an Arizona automobile license, sheet metal fragments, a round nail, a piece of copper wire, two pieces of purple glass, and several fragments of an amber beer bottle, probably of recent origin. Below the retaining wall is what appears to be part of a small sheet metal stove.

Structure 12

A leveled area, slightly cut into the hillside and built up a bit on the front with a line of rock, marks another possible structure area, Structure 12. This measures 12 feet by 15 feet on a southwest-northeast axis, roughly perpendicular to the river. It is possible that this was the location of a shepherd's tent shown in a photograph of the area taken ca. 1924 (Figure 15).


Artifacts in and around the area consist of at least three large butchered bones and several fragments, modern style food cans, hole-in-top condensed milk cans, a large key opening coffee-type can, a cone top crown top can (possibly a beer can), a friction top can 6.50 inches in diameter and 5.75 inches tall with a homemade wire handle making it a bucket, angled sheet metal with nails pounded through at regular intervals, a short length of sheep fence, and a bottle base marked "DESIGN PATENTED AUG. 5th. 1919; "



Figure 14. Log cribwork of Structure 11 as it appeared in 1943 (Source: Kelly 1943:6).



Figure 15. Ferry in operation circa 1924. Several Structures are apparent at the Main Ferry Landing in the background: log cribwork (Structure 11), log cabin (Structure 2) without the porch addition, sheep-herders tent (Structure 12) left of Structure 2, and ramada far left (Structure 13). Note that there is no evidence of presence of Structure 1. (Source: Northern Arizona University, Special Collections Library Photo and illustrated in Measeles 1981:55).

Structure 13

Structure 13 is a rather indistinct leveled area about 35 feet northwest of Structure 1, measuring roughly 12 feet square and set parallel to the river. The west elevation is delineated by an alignment of sandstone rock forming a slight retaining wall on the downhill side. The area is covered by round nails, indicating that a frame structure was probably present at one time. In fact, historic photos show an open air ramada in this location (Figures 15 and 22).

Besides nails, other artifacts include clear glass vessel fragments, pieces of plain white glazed earthenware, a piece of brown glazed stoneware, the key wind from a sardine or coffee can, baling wire, wire fragments, part of a 1.75 inch diameter friction top lid, .22 Long cartridges marked "U" and "Super X", .22 Winchester Rim Fire cartridge marked "U", a .32 caliber cartridge marked ".32 Ex L. U.M.C.", the threaded end of a bolt, a small machine head screw (possibly from a carburetor), a windshield wiper, a rubber wiper blade fragment, a brass sheet metal gasket with packing material inside (1.5 inches in diameter), a file fragment, orange rubber (hose fragment?), pieces of leather, and a piece of lead babbitt, probably from a connecting rod in a car engine.

Structure 14

Structure 14, north of Structure 3 about 90 feet, is a very small cleared area on a slight ridgeline. The area measures 3 feet by 8 feet, roughly on a north-south axis, with an alignment of rock at the south end. Artifactual evidence indicates that this "structure" may be quite recent, as a foil "HI-C" fruit punch container and a clear glass fruit juice bottle neck with metal screw top were found here. Most likely this location was cleared of rock for a one-time sleeping spot.

Structure 15

On the southeast side of the corral (Structure 4) are some indistinct and incomplete rock alignments, designated Structure 15. These adjoin the south wall of the corral in two places but do not form any distinct enclosures. One of these alignments begins at the southeast corner of the corral and projects south for a distance of about 30 feet, away from the corral wall, where it crosses the existing footpath. It then veers east about 18 feet in an arc and terminates where it meets the footpath again. A second short segment of wall begins about one-third of the way down the south wall of the corral and projects east for about 10 feet, not quite connecting with the wall described above. These alignments or walls were constructed by filling in gaps between existing large boulders with rock of various shapes and sizes. Wall heights reach up to 4 feet, with the widths varying from 4 feet to 12 feet.

Dugway and Roads through Site

The road or dugway leading to the site is recognizable and in reasonably good condition for 1/4 mile from the top of the rise just west of the remains of the steamship Charles H. Spencer, where the Spencer Trail begins, to the Main Ferry Landing (Figure 16). From the present-day boat ramp to the Spencer Trail, the historic roadbed ranges from indefinite to nonexistent due to erosion and subsequent use of the area. The intact segment, leading to the Main Ferry Landing, has been leveled into and built out from the moderately steep and rocky hillside above the Colorado River, keeping the grade fairly level over its entire length. At the present time, the dugway is used as a fishermen's trail. It is impassable to vehicles and receives no maintenance.

A separate report has been completed concerning the stabilization assessment of the dugway leading up to the Main Ferry Site (Horn and Eininger 1986). Although this was part of the Year 3 work, this information has been submitted as a separate manuscript as per the requirements of the Statement of Work, Change Order No. 4.

Maintenance of the route was probably a continual problem while the ferry was in operation. Encroachment from above by rock and boulder fall as well as general slope movement has narrowed and cluttered the road considerably in some places. Erosional channels have also cut across the dugway in a few spots, making passage difficult. However, the basic roadbed is in remarkable condition overall, considering it has been unmaintained for over 50 years.

As the dugway approaches the Main Ferry Site it gradually curves to the south, following the bend of the Colorado River below. Just before the site is reached the road crosses an erosional drainage and turns sharply south past a huge boulder. Facing the road on the east side of the boulder an inscription reads "H.K. WHITE AUG 27(?) 1921."

It is at this point that the road ceases to be a dugway and simply becomes a surface roadway, branching in several directions and crossing the center of the site (See Map 1, in map pocket). About 90 feet south of the boulder, a trace of a road can be seen branching off to the west and ending at Structure 13. A few feet beyond this the road forks. The road taking off to the right heads down to the river, disappearing into the sand just above the cleared beach where the ferry landed. The left fork gradually bends to the southeast. Another fork is encountered about 50 feet beyond the last. The south or right fork is visible to a point just below Structure 11 where it disappears into the sandy soil. This may have continued farther at one time, forming a low road across the site. The left branch traverses above Structure 11. Just west of a deep erosional channel 150 feet beyond Structure 11, it is joined by a road from below, probably a continuation of the low road mentioned above. After crossing the drainage, the road becomes very indistinct. It passes just above Feature 5 and then appears to continue to the west side of the corral, Structure 4. There is no indication of the road extending on to Structure 5.

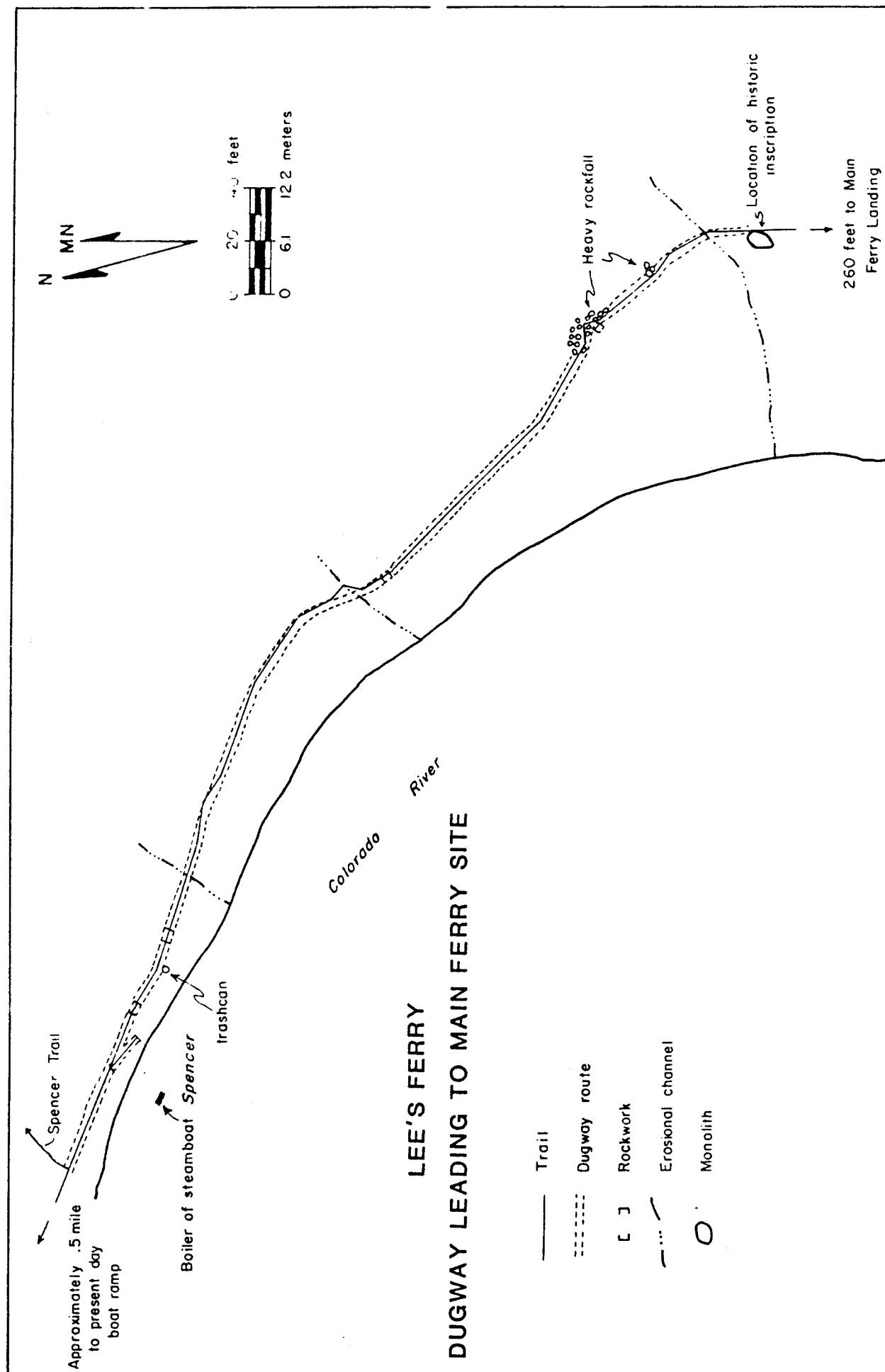


Figure 16. Sketch map of the dugway route leading to the Main Ferry Site.

Feature Descriptions

Feature 1

Feature 1 is a simple dry-laid, native sandstone rock windbreak constructed against a large overhanging boulder on the rocky slope above the main ferry buildings. The windbreak, single stone and three to four courses high (maximum height is 28 inches), is built out from the west end of the south side of the boulder. It runs parallel to the overhang, forming a protected area roughly 3 feet square. No artifacts were found associated with this feature; however, it does appear that a campfire was built within its confines.

Feature 2

Feature 2, on the north bank of the erosional drainage just below (west of) Structure 3, is an isolated fire ring probably of recent origin. This fire ring uses the protection of a large boulder that overhangs the its southeast half. The northwest half is constructed of several irregular sandstone rocks. Feature 2 measures 2 feet by 3 feet, with its length running parallel to the boulder. Charcoal and ash are present within the hearth, with some charcoal scattered outside to the south. A piece of eggshell and a fragment of a clear glass vessel are present in the fire ring. Nearby is some aluminum foil and the end of a modern style food can.

Feature 3

Feature 3 is a trash dump in the erosional channel beginning on the south side of Structure 2. An area where trash was burned and dumped into the arroyo is located on the north bank of the drainage about 20 feet west of the structure. It is quite reasonable to assume that the material deposited at this location was generated at Structure 2, which is adjacent. Artifacts are scattered down the drainage for a distance of about 65 feet.

The majority of artifacts in the feature are various types of cans. These include hole-in-top condensed milk cans, modern style food cans, tobacco cans, a key opening coffee can, a rectangular key opening Spam-type can, a key opening sardine can marked "NORVEGE" on the bottom, a small, flat seamed round can with an offset friction lid marked: "PAT. 1838217", a rectangular syrup type can, and a round 5-gallon kerosene or gasoline can with a cone top. Glass items include purple, clear, light green, amber, and aqua vessel fragments (some of which have been melted), clear screw top canning jar fragments (including pieces of a Ball Self Sealing jar and a Strong Shoulder Mason jar), aqua paneled medicine bottle fragments, a clear medicine bottle neck made in an automatic bottling machine, a clear screw top food jar (possibly mustard) made in an automatic bottling machine, a clear glass whiskey bottle neck made in an automatic bottling machine, amber beer bottle fragments, clear lantern glass with a ground lip, pieces of a white milk glass cream jar, and fragments of a white milk glass Mason jar lid liner. Ceramic items are plain white glazed earthenware, a fragment of white porcelain, an unglazed stoneware fragment, and pieces of stoneware glazed brown on the

interior and white on the exterior. Organic material is represented by eggshells and pieces of bone. Shoe or boot uppers, one shoe sole, and a brass suspender or overall adjuster make up the personal items present. Construction materials are composed of round nails and window glass. Other miscellaneous items include a barrel hoop, a brass valve stem from an automobile tire, and wire.

On the south bank of the drainage, opposite the trash burning area, are pieces of amber and aqua beer bottles the bases of which are marked "B1" and "①", respectively. Nearby is a concentration of artifacts composed of modern style food cans, window glass, and vessel glass. One hole-in-cap condensed milk can is marked "THE BORDEN COMPANY, EAGLE BRAND". A fragmentary clear glass, paneled medicine type bottle is marked: "THE S ____ G. CO." around a logo of some sort.

Feature 4

Feature 4, another trash dump, is apparently related to Structure 7. It is located directly west of that structure and consists mainly of cans scattered down the rocky hillside onto the floodplain below. Material covers an area roughly 10 feet by 25 feet in a more or less linear fashion running north to south. Artifacts consist of modern-style food can fragments, hole-in-top and hole-in-cap condensed milk cans and can fragments, the top of a square 5-gallon kerosene can with a wire loop handle and screw valve pour spout, an irregularly shaped piece of galvanized sheet metal, fragments of a clear glass vessel, and pieces of eggshell.

Feature 5

Feature 5, about 400 feet upstream from the ferry landing itself, 55 feet west of Structure 4, and 30 feet upslope from the river, is a large sandstone boulder roughly 5 feet in diameter around which is wrapped a length of 1/2 inch cable (wire rope). This cable was probably attached to the main cable to keep it from bowing too far downstream.

Feature 6

Feature 6 is a pile of small angular sandstone rocks, of unknown function, about 4 feet in diameter. It is located about 125 feet southeast of Structure 11.

Feature 7

Feature 7, located about 15 feet northwest of Structure 1, is a large accumulation of angular sandstone in a mounded, circular pattern about 9 feet in diameter. Remnants of sawn lumber, window glass, amber vessel glass, leather, and cotton belting are scattered around the vicinity. The function of this feature is unknown.

Feature 8

A fire ring, 2.5 feet by 3.0 feet, made of sandstone cobbles makes up Feature 8. It is located beneath the large cottonwood tree west of Structure 14. No artifacts were found associated with this feature.

Feature 9

Feature 9, another small fire ring measuring 20 inches by 24 inches, is located about 60 feet northwest of Structure 3. This feature is made of small sandstone cobbles, some of which have rolled into the center of the fire ring. Charcoal is present.

Feature 10

Feature 10, located about 50 feet west of Structure 3, is a small can dump. At least 18 cans are present in a 2.5 foot by 6.0 foot area. The cans are made up entirely of modern-style food cans and hole-in-top evaporated milk cans.

Feature 11

In the area between Structures 9 and 13 is Feature 11, a fire ring measuring 18 inches by 24 inches. Some large sandstone rocks were used in situ to form a portion of this ring with smaller rocks brought in to round it out. Some charcoal is in evidence, and a nickel plated .22 cartridge marked "HI SPEED U" was found within the fire ring.


Historic Artifacts

In general, the number of historic diagnostic artifacts found at Lee's Ferry was lower than expected. The historic artifacts recovered at the site were analyzed as to their function. According to Roderick Sprague (1981:252), "the purpose of a historic site study is to contribute to our understanding of the culture as a whole. This requires a knowledge of the function of cultural elements discovered in that site." Furthermore, Sprague goes on to state, "function is the highest and most productive basis for site analysis." The classification utilized in this study is a combination of that proposed by Sprague (1981:255-258) and a museum collection classification system devised by Robert G. Chenail (1978:21-53).

Containers and Lids

Collected from the site were eight glass vessel fragments - bases, necks, and body pieces - and three lids. Each of these items has temporally diagnostic marks or features (Table 2).

Glass Vessels

Amber beer bottle base, 2½ inches in diameter. Marked: 21  3 (Figure 17d). This bottle was made by the Owens-Illinois Pacific Coast Company, a subsidiary of the Owens-Illinois Glass Company, at their plant in Portland, Oregon in 1933 (Toulouse 1971:406-407).

Amber beer bottle base fragment, 2½ inches in diameter. Marked: "B1" (Figure 17c). The embossed mark on the base of this bottle is probably the mould number. The manufacturer's mark is not present on this fragment. Mould seams indicate that this vessel was manufactured

TABLE 2
DISTRIBUTION OF CONTAINERS AND LIDS

[illegible]

35

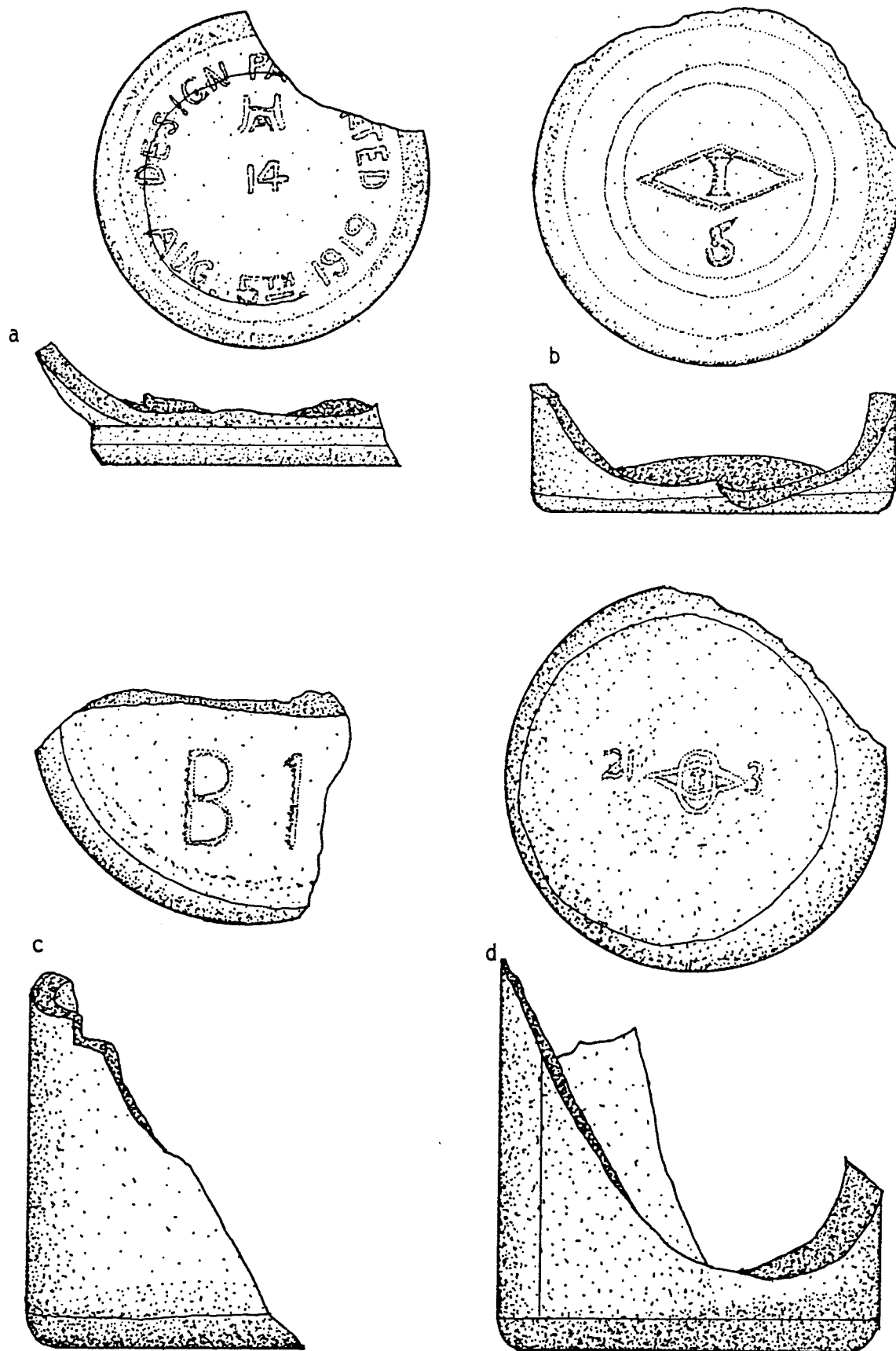




Figure 17. Diagnostic Bottle Bases. a, clear jar base; b, aqua beverage bottle base; c and d, amber beverage bottle bases.

in an Owens automatic bottling machine and therefore dates after 1904 (Miller and Sullivan 1983:95).

Aqua bottle base, 2½ inches in diameter. Marked: "  " (Figure 17b). This mark indicates manufacture by the Illinois Glass Company between 1916 and 1929 (Toulouse 1971:264).

Clear jar base, 2½ inches in diameter. Marked: "  ", "DESIGN PATENTED AUG. 5th. 1919" (Figure 17a). The manufacturers mark on this bottle base shows that this vessel was manufactured by the Hazel-Atlas Glass Company between 1920 and 1964 (Toulouse 1971:239). The presence of the 1919 patent date probably indicates that this vessel was made in the 1920s.

Fragmentary clear paneled medicine or extract bottle. Base marked: "PAT. NO. D-89237" (Figure 18d). This is probably a design patent for the bottle itself. Mould seams on this vessel indicate manufacture in an Owens automatic bottling machine, dating it to after 1904 (Miller and Sullivan 1983:93,95).

Base and side panel fragment of a clear, paneled medicine or extract bottle. Side panel marked: "THE S _____, _____ G CO." around a logo of some sort below which is embossed "TRADE MARK" (Figure 18c). A mould seam on this vessel again indicates a post-1904 manufacture data in an Owens automatic bottling machine (Miller and Sullivan 1983:95).

Clear medicine bottle neck. Seams show that this vessel was made in an automatic bottling machine and therefore dates after 1904 (Miller and Sullivan 1983:94). The style of the neck is a reinforced, double ring, prescription lip (Figure 18b).

Clear liquor bottle neck. This vessel fragment appears to have been manufactured in an automatic bottling machine and therefore dates after 1904 (Figure 18a).

Lids

Baking Powder lid, 2-3/8 diameter with 3/4 inch sides. Marked: "CALUMET, 8 oz., BAKING POWDER, MADE IN U.S.A., _____" (Figure 191). This is a stamped sheet metal, friction lid from a baking powder can. No information on the possible age of this lid could be found; however, Calumet baking powder is still being marketed.

Sheet metal cap, 3-1/4 inch diameter with 1/4 inch sides. This cap may be a canning jar lid used on Economy fruit jars. Lids for this jar were patented in 1903 (Toulouse 1977:26).

Canning jar zinc cap. Zinc screw top canning jar lids were first developed for shoulder sealing Mason jars in the mid-nineteenth century. They found wide use through the 1920s and 1930s and may still be obtainable today.

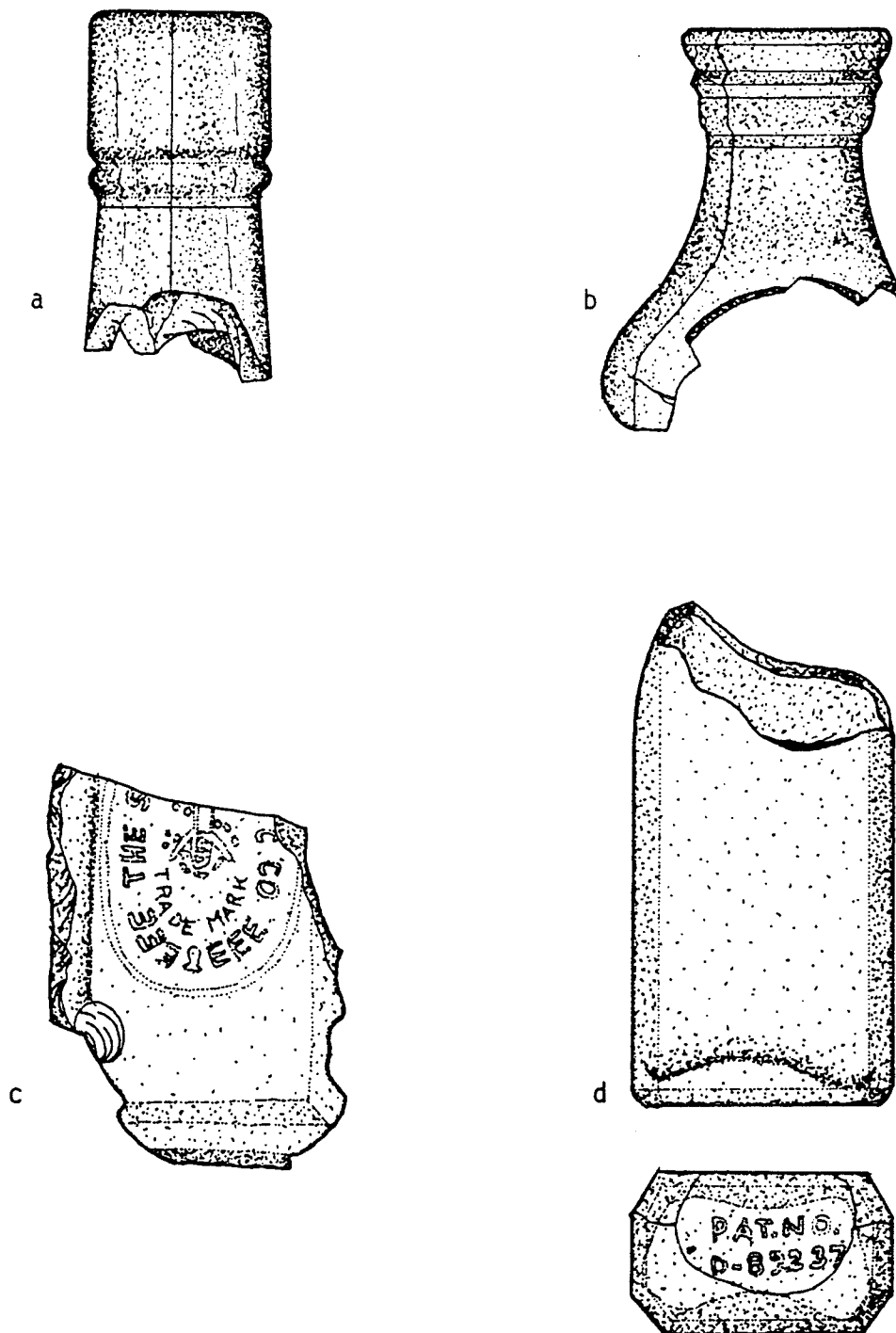


Figure 18. Diagnostic Bottle Fragments. a, clear liquor bottle neck; b, clear medicine bottle neck; c, embossed side panel fragment; d, clear bottle body and base.

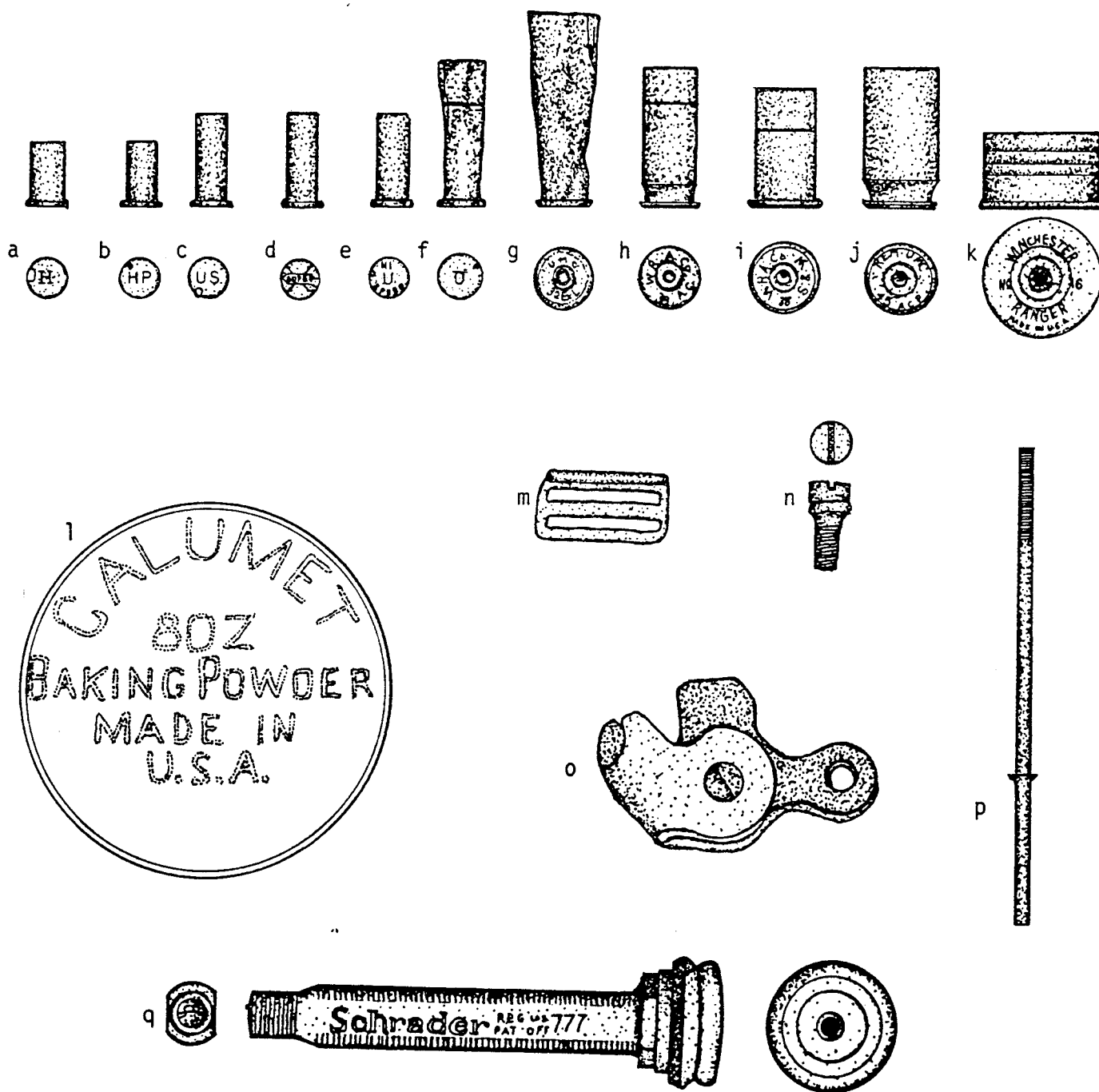


Figure 19. Miscellaneous Artifacts. a, .22 CB Cap; b, .22 Short; c-e, .22 Long; f, .22 Winchester Rimfire; g, .32 Ballard Extra Long; h, .38 Colt Automatic; i, .38 Smith & Wesson; j, .45 Automatic; k, 16 gauge Winchester Ranger shotgun shell; l, Calumet baking powder lid; m, overall or suspender adjuster; n, machine screw; o, carburetor valve linkage; p, possible carburetor part; q, automobile tire valve stem.

Personal Items

Items falling within this category were "originally created to serve the personal needs of individuals as clothing, adornment, body protection, grooming aids or symbols of beliefs or achievement" (Chenall 1978:25).

Overall or Suspender Adjuster

The only artifact from this category was a brass overall or suspender adjuster (Figure 19m). It measures 7/8 inch in length and is 7/16 inch wide with one rolled edge.

Tools and Equipment

Items categorized as tools and equipment are those "originally created to be used in carrying on an activity such as an art, craft, trade, profession or hobby; the tools, implements and equipment used in the process of modifying available resources for some human purpose" (Chenall 1978:26).

Armament-Ammunition

A total of 21 cartridge cases was collected from the site area. Five of these were centerfire cartridges, with the remainder being rimfire (Table 3).

Centerfire Cartridges:

.45 Automatic Colt Pistol. Headstamp: REM-UMC 45 ACP. (Figure 19j). This cartridge was developed in 1905 and adopted as the official U.S. military handgun cartridge in 1911. It was used in the Colt-Browning automatic pistol. In the U.S., the Colt Government Model and the Smith & Wesson Army Model 1917 revolvers use this cartridge. This size is also used as the official caliber of the governments of Mexico, Argentina, and Norway. This is a combat cartridge, more useful for target shooting than hunting (Barnes 1972:171).

.38 Colt Automatic. Headstamp: W.R.A. CO. .38 A.C. (Figure 19h). This is a .38 Colt automatic cartridge made by Winchester Repeating Arms. It was introduced in 1900 for the Colt .38 automatic pistol. No guns for this cartridge have been made since 1928. It was developed for self-defense but has been used for hunting (Barnes 1972:164).

.38 Smith & Wesson. Headstamp: W.R.A. CO. .38 S&W (Figure 19i). The .38 Smith & Wesson was introduced about 1877 and has since been one of the most widely adopted cartridges in the world. Its use is almost strictly for short-range self-defense (Barnes 1972:163).

.32 Ballard Extra Long. Headstamp: U.M.C. .32 Ex L (Figure 19g). This cartridge did not appear until about 1879 and was phased out by the .32-20 WCF. It stopped being loaded by 1920. Target shooting and hunting of small game was its main use (Barnes 1972:80). The U.M.C. mark indicates manufacture of this particular example before the merger

TABLE 3
DISTRIBUTION OF CARTRIDGES

Description	Type	Headstamp	Structure 2	Structure 4	Structure 7	Structure 9	Structure 12	Structure 13	Feature 3	Feature 7	Feature 11	General Site	Total	Map Reference
.45 Automatic Colt	Centerfire	REM-UMC .45 ACP	1										1	A
.38 Colt Automatic	Centerfire	W.R.A. Co. .38 A.C.							1				1	B
.38 Smith & Wesson	Centerfire	W.R.A. Co. .38 S&W		1									1	C
.32 Ballard Extra Long	Centerfire	U.M.C. .32 Ex. L.						1					1	D
.22 CB Cap	Rimfire	H (impressed)										1	1	E
.22 Short	Rimfire	HP (impressed)							1				1	F
.22 Long or Long Rifle	Rimfire	U (impressed)	1					1				1	3	G-I
.22 Long or Long Rifle	Rimfire	H (impressed)	1						1	1			3	J-L
.22 Long or Long Rifle	Rimfire	Hi Speed U (impressed)									2		2	M-N
.22 Long or Long Rifle	Rimfire	US (impressed)			1								1	O
.22 Long or Long Rifle	Rimfire	Super X (impressed)						2				1	3	P-R
.22 Winchester Rimfire	Rimfire	U (impressed)						1					1	S
.22 Winchester Rimfire	Rimfire	H (impressed)						1					1	T
16 Gauge Shotgun Shell	Centerfire	Winchester Ranger No. 16	1										1	U
Total			4	0	2	0	0	6	3	1	2	3	21	

of Remington with the Union Metallic Cartridge Company in 1902, resulting in a date of manufacture for this cartridge between 1879 and 1902 (Berge 1980: 224).

Winchester Ranger No. 16 Shotgun Shell. The date of manufacture for this cartridge is unknown. However, it is probably recent and certainly dates after 1901 (Figure 19k).

Rimfire Cartridges:

.22 CB Cap. Headstamp: H (impressed) (Figure 19a). A single cartridge of this size was collected. This cartridge appears to have been introduced about 1888 and was discontinued after World War II. It was an enlarged version of the .22 BB cap used as an indoor target round and capable of killing only very small game. It is generally considered to be a useless variation (Barnes 1972:273). The impressed "H" base mark indicates manufacture by Winchester Repeating Arms (Berge 1980:224).

.22 Short. Headstamp: HP (impressed) (Figure 19b). The .22 Short was the first self-contained commercial metallic cartridge. Introduced in 1857, it is still manufactured today for target shooting and hunting of very small game (Barnes 1972:273). The headstamp, "HP", indicates manufacture by Federal Cartridge Company, in business from 1920 to the present (Logan 1959:190; Kass 1979:F-8).

.22 Long or Long Rifle. Headstamps: U, H, Hi Speed U, US, Super X (all impressed) (Figure 19c-e). Twelve cartridges of this size, having five different headstamps, were collected. The .22 Long and .22 Long rifle use the same case but were introduced in 1871 and 1887, respectively. Both are still available today, with the .22 Long rifle being the most popular cartridge in existence. It is now used for small game hunting and target shooting. Three cartridges are marked with an impressed "H", indicating manufacture by Winchester Repeating Arms some time between 1867 and the present. The three marked with a "U" were made by the Union Metallic Cartridge Company between 1890 and the present. Two "Hi Speed U" cartridges were recovered, probably dating after 1930 (Berge 1980:224, 227). Three "Super X" cartridges made by Winchester from the mid-1930s to the present were found (Kass 1979:SU-1). A single cartridge with an impressed "US" headstamp was collected. This was manufactured by the United States Cartridge Company, probably between 1870 and 1936 (Teague and Shenk 1977:148).

.22 Winchester Rimfire and Remington Special. Headstamps: H and U (impressed) (Figure 19f). This size cartridge was introduced for the Winchester Model 1890 pump or slide action rifle and is still made today, though no rifles are made for it. It was an improvement over the .22 Long for small game hunting (Barnes 1972:275). The two examples are marked "H" and "U", indicating manufacture by Winchester after 1867 and the Union Metallic Cartridge Company after 1890, respectively (Berge 1980:224, 227).

Animal Husbandry

Horseshoe Nail. A single horseshoe nail was collected from the general site area (Table 4).

Animal Powered Land Transportation Equipment

Harness Ring: This category is represented by a single broken harness ring (Table 4). The ring appears to be handmade of 1/2 inch round stock and measures 3 inches in diameter. One side has been flattened to a thickness of 1/4 inch; it has been broken in half.

Automobile Transportation (Table 4)

Windshield Wiper. Marked: THE ANDERSON COMPANY, GARY, INDIANA; MADE IN U.S.A.; TRADE SLEET-MASTER MARK; STAINLESS STEEL; and PATS. PEND.

This is a two-piece windshield wiper, 6 inches long, made of stamped steel. It was made so that a rubber wiper blade could be removed and replaced as needed. The wiper is held together by a simple lever clasp at the center. A bracket that projects through this clasp would have been attached to the wiper arm.

According to Eric L. Mundell of the Indiana Historical Society Library (1985: personal communication) the Anderson Company was founded by John W. Anderson in 1918. The company was moved to Gary, Indiana in 1923 where it remained until late in 1984, at which time operations were centralized at Michigan City, Indiana. The company's main emphasis has always been on the manufacture of windshield wipers.

Carburetor Part. What appears to be an iron operating arm for a carburetor butterfly valve was collected (Figure 19o). Other items that may be carburetor parts are listed under "Items of Unknown Function."

Lead Bearing Babbit. A piece of lead was collected, shaped as though it had been used as a bearing babbitt, probably from a connecting rod.

Gasket. A rolled brass sheet metal gasket 1-1/2 inch in diameter filled with fibrous packing was found. This may also be from an automobile's carburetion system.

Brass Valve Stem for Tire. Marked: "SCHRADER REG. U.S. 777"
PAT. OFF.

This is a piece of brass 3-1/16 inches long, 3/8 inch diameter, with a 13/16 inch diameter head on one end tapered to 5/16 inch on the other. The entire length below the head is threaded. A lock nut is in place holding what appear to be two rubber spacers and a brass washer. A hole has been machined through the entire length through which the end of the interior valve can be seen (Figure 19q).

A valve stem also made by Schrader was recovered from Site 45WT104A, the Ferry Tender's Site at Silcott, Washington (Adams, Gaw,

TABLE 4

DISTRIBUTION OF ARTIFACTS OF MISCELLANEOUS FUNCTIONS

Category	Description	Structure 2	Structure 4	Structure 7	Structure 9	Structure 12	Structure 13	Feature 3	Feature 7	Feature 11	General Site	Total	Map Reference
Personal Items	Overall or Suspender Adjuster							1				1	GG
Tools and Equipment - Animal Husbandry	Horseshoe Nail										1	1	HH
Tools and Equipment - Animal Powered Land Transportation Equipment	Harness Ring	1										1	II
Tools and Equipment - Automobile Transportation	Windshield Wiper					1						1	JJ
Tools and Equipment - Automobile Transportation	Carburetor Part							1				1	KK
Tools and Equipment - Automobile Transportation	Lead Bearing Babbitt							1				1	LL
Tools and Equipment - Automobile Transportation	Gasket						1					1	MM
Tools and Equipment - Automobile Transportation	Tire Valve Stem "Schrader"								1			1	NN
Tools and Equipment - General	File Fragment						1					1	OO
Tools and Equipment - General	Hacksaw Blade Fragment	1										1	PP
Total													10

and Leonhardy 1975:81-82, 264). This was almost identical to the one found at Lee's Ferry except for a flared washer and the number "825" instead of "777" found on the item's side. The Ferry Tender's Site has been dated between 1910 and 1930.

General Tools and Equipment (Table 4)

File. A fragment of a second cut, flat mill file 15/16 inch wide, 3/8 inch thick, 1-7/8 inch long was found.

Hacksaw blade. One fragment of a hacksaw blade 1/2 inch wide, 1-7/8 inch long, with 18 teeth per inch was recovered.

Items of Unknown Function

Three items of unknown function were found (Table 5).

Screw

A slotted, fillister head machine screw with lock washer was recovered (Figure 19n). This is 9/16 inch long, 1/8 inch in diameter, with a thread length of 7/16 inches. Screws of this sort are commonly found on carburetors.

Chromed Brass Item

A 3/32 inch diameter piece of chromed brass, 3-1/16 inches long, threaded for 9/16 inch on one end with a 3/16 inch flange one inch down from the other end was collected. This has the appearance of having been made to precise specifications such as would be expected in something like a carburetor for an automobile (Figure 19p).

Strap Iron Fragment

A single piece of strap iron was collected. This measures 3/4 inch wide by 7-1/2 inches long with two countersunk holes spaced 6 inches apart on center. Hardware such as this was commonly used in the construction of wagon beds.

Conclusions Based on Historical Research

Both the artifacts collected and observed and the historical record appear to indicate that the Main Ferry Site was not utilized until after the cable was placed across the river in 1898. No artifacts were found that could be dated as having been manufactured prior to the placement of the cable. Construction details and photographic documentation were of no great assistance in dating the many structures, structure areas, and features at the site. Photographs enabled the determination of whether certain structures were present during the operation of the ferry (1898 through June 1928) and provided some indication of function. Historical documentation concerning the locations of the early ferry landings at use at Lee's Ferry, though slim on specifics, was substantial enough to make clear the fact that three locations had indeed been

TABLE 5
DISTRIBUTION OF ITEMS OF UNKNOWN FUNCTION

Description	Possible Function	Structure 2	Structure 4	Structure 7	Structure 9	Structure 12	Structure 13	Feature 3	Feature 7	Feature 11	General Site	Total	Map Reference
Screw	Automotive Carburetor						1					1	QQ
Threaded Chromed Brass Item	Automobile Carburetor						1					1	RR
Strap Iron Fragment	Wagon Hardware			1								1	SS
Total		0	0	1	0	0	2	0	0	0	0	3	

used, the last being the Main Ferry Landing. Previous assumptions that the original, upper ferry crossing was at the same location as the Main Ferry Site are entirely unsupported.

The most temporally diagnostic artifacts collected from the site were cartridges and glass vessel fragments and lids. Of the cartridges collected, few can be definitely placed within the period during which the ferry was in operation; only one, the .32 Ballard Extra Long, can be dated so as to have a strong possibility of having been deposited prior to 1902. The .45 Automatic Colt Pistol, .38 Colt Automatic, and .38 Smith and Wesson all may date to the later period of ferry operation. It is interesting to note that all three of these were developed and used primarily for self-defense. With the exception of the shotgun shell, the remaining cartridges from the site are all varieties of .22 caliber shells. None of these are very good as temporal indicators. However, the .22 Long cartridge marked "US" probably dates to the ferry operation, and those marked "Hi Speed U" and "Super X" certainly date afterward. It is very likely that the vast remainder of the .22 cartridges collected also postdate the ferry operation and indicate visitation to the site for recreational purposes up to at least the 1974 acquisition by the NPS.

Although all but one of the glass vessels and lids collected at the site may date to the ferry period, none date before 1900. Those containers that are of clear glass probably date to after World War I since, prior to that time, manganese was used as a clearing agent, causing the glass to subsequently change to purple with exposure to the sun. As these items have not changed in color, it is very likely that their manufacture took place after the use of manganese was discontinued.

It is interesting to note that of the artifacts which fall into the tools and equipment category, only three items, a horseshoe nail, harness ring, and a possible piece of wagon hardware, may relate to non-mechanized transportation. Compared to the five artifacts known to have come from automobiles and two possible automobile-related artifacts collected, this is a very small percentage, especially considering that the first automobile did not arrive at Lee's Ferry until about 1910 (Crampton and Rusho 1965:5). The distribution of automotive artifacts, four items from Feature 13 and three from Feature 3, appear to indicate locations of automobile repair. This is further substantiated by the appearance of the only two general tools, a hacksaw blade and file fragment, found at Structure 2 (directly associated with Feature 3) and Feature 13, respectively.

Judging from the artifacts alone, it would appear that occupation of the site probably was initiated just prior to 1902. Most intensive use of the area would have been during the 1910s and 1920s, primarily in the later decade, with sporadic use thereafter, mainly for recreation purposes. A scenario of this sort corresponds very well with what is known of the history of Lee's Ferry and argues strongly for the position that the Main Ferry Site was not utilized until the cable was placed across the river in 1898, and that another landing site, presumably near Lee's Ferry Fort, was used as the Upper Ferry Crossing until that date. The artifacts would also suggest that use of the site for habitation or

as a stopover point with a corresponding increase in artifact deposition may have taken place as a result of increased automobile traffic after 1910, the acquisition of the ferry by Coconino County in 1910, or both.

A number of photographs of the Main Ferry Site were found in the literature. The orientation of those photographs showing structures was duplicated at the site. This enabled us to correlate photodocumented structures to specific structures or structure locations on the ground. An undated photograph in Desert River Crossing by W.L. Rusho and C. Gregory Crampton (1981:80) shows three standing structures (Figure 20). To the left of the photo is a building identified as the "Louse House" used to accomodate overnight visitors. This corresponds to Structure 1, which is still partly standing and which was stabilized during this project (Figure 21). To the right, a pole frame open air ramada with a brush roof is partially shown. Structure 13 corresponds to this location. At the center of the photo, the top of the log cribwork over which the ferry cable passed and to which it may have been attached can be seen. The leveled area at Structure 11 fits this location and is verified through other photographs. Although this photograph is undated, the presence of the Hoskaninni Company's mining road on the south bank dates it to after 1899. The photograph on the cover of Evelyn Brack Measeles' book Lee's Ferry: A Crossing on the Colorado (1981) clearly shows the log cribwork at Structure 11 with a log cabin behind and slightly to the left (Figure 22). This corresponds to the north half of Structure 2 (Figure 23). It is interesting to note that nowhere in this 1925 photo nor in photos from this direction dating to 1921 and 1924 found elsewhere in the book (Measeles 1981:54-55) (Figure 15) is there any indication of a structure making up the south half of Structure 2. Two photographs have been found that show the south wall of the structure in place. One of these photos (Crampton 1986:131) (Figure 9) is undated; however, the other appeared in a 1943 article describing a recent visit to the site (Kelly 1943:6) (Figure 8). It can therefore be concluded that sometime between 1925 and 1943 the porch composing the south half of Structure 2 was added onto to the existing cabin. The 1924 photograph mentioned above (Measeles 1981:55) (Figure 15) shows what appears to be a sheepherder's tent to the north of the log cabin (Structure 2). A leveled area at the base of the hillside, designated Structure 12, corresponds very well with this location.

One peculiarity of the photographic record is apparent. In none of the 1920s photographs taken looking back toward the Main Ferry Site can any indication of Structure 1 be discerned. That Structure 1 was present while the ferry was in operation is shown by the undated Desert River Crossing photo of the "Louse House" mentioned previously (Figure 20). It reappears in Kelly's 1943 photo (Figure 8) and is present at the site today. Three explanations for this are possible. The first is that the building simply blends into the rocky background and is therefore not visible in the majority of photos dating to the ferry operation. Second, the structure may have been built after 1925, the date of the most recent of the photographs looking back across the river toward the site, and prior to the destruction of the ferry in mid-1928. Third, the structure may have fallen into disrepair sometime before the 1920s photographs were taken, appearing to be a rubble pile, and was then rebuilt sometime prior to 1943.



Figure 20. Undated historic photo showing "Louse House" on left (Structure 1), top of log cribwork (Structure 11) in center, and pole frame ramada (Structure 13) on right. (Source:Rusho and Crampton 1981:80).



Figure 21. Reconstruction of historic photo above (Figure 20) showing Structure 1 on left to be the "Louse House" and the clearing on the right (Structure 13) to be the location of the ramada.

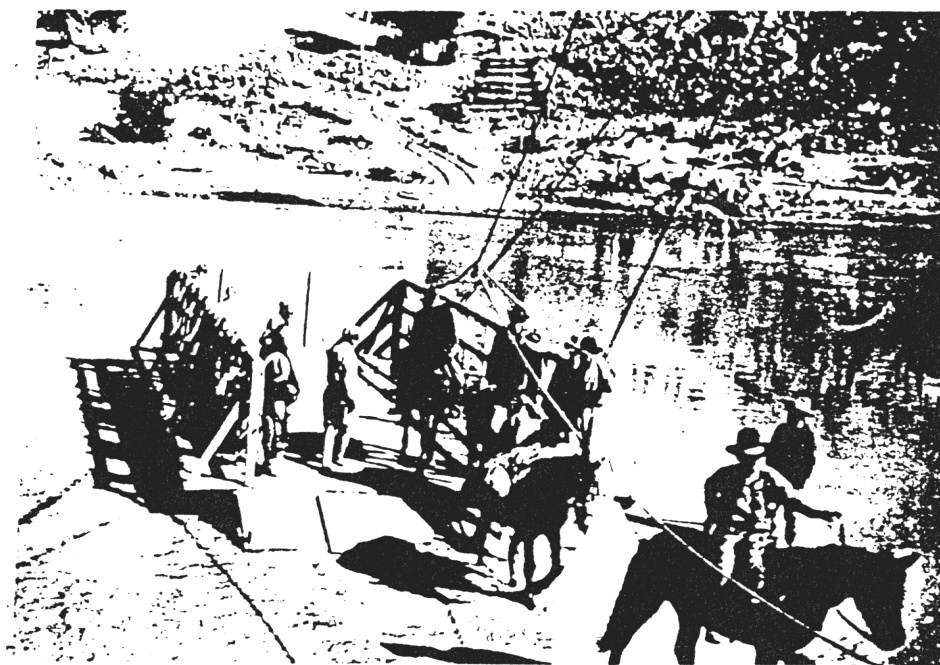


Figure 22. View of Ferry in 1925 (Source: Measeles 1981: Cover). Note log cribwork (Structure 11), and log cabin (Structure 2) without the porch addition. Also note that Structure 1 is not evident.

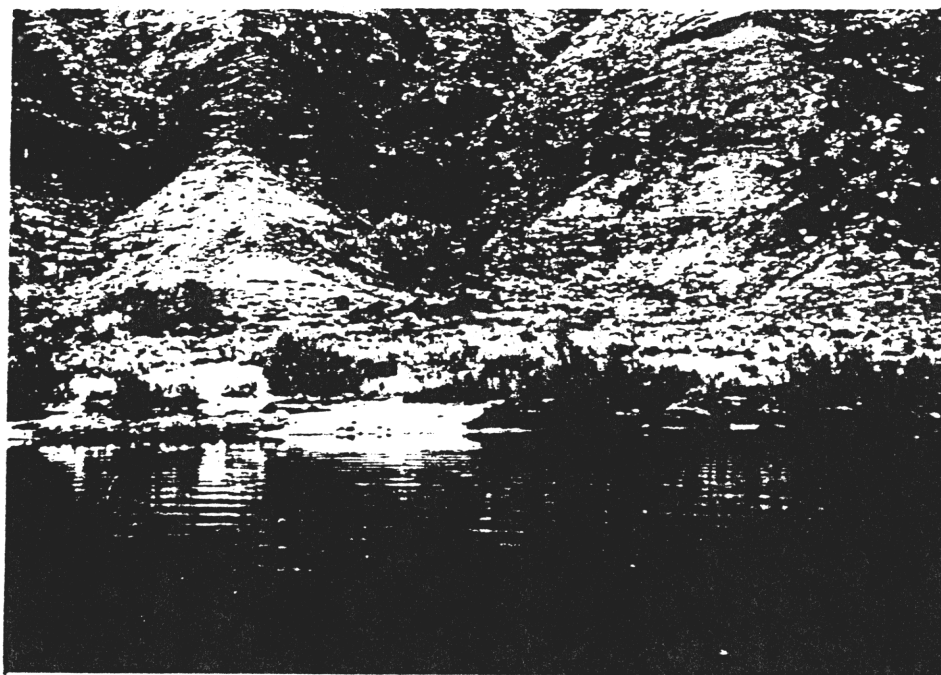


Figure 23. View of Main Ferry Site from across the river at approximately the same angle as the historic photo in Figure 22. Note location of Structures 1(a) and 2(b).

Crampton and Rusho (1965:9) reported that the Original Ferry Site, used by John D. Lee in 1873, was located upstream of the Paria River just below the remains of the steamboat Charles H. Spencer. This would place it just above Lee's Ferry Fort, an excellent location that would have afforded access on both sides of the river and the ability to pull the boat upstream the required distance needed to compensate for the drift of each crossing. However, Crampton and Rusho also state that the site was probably not used again after the loss of the ferry boat Colorado in June of 1873, in favor of the Main Ferry Site upstream. This assertion is not substantiated by either the artifacts present at the Main Ferry Site or the constraints presented by the terrain, especially on the south bank.

As described above, none of the artifacts collected or observed at the Main Ferry Site during the project dated prior to the placement of the cable across the river in 1898. The location chosen for the cable crossing is somewhat narrower than downstream and afforded a solid anchoring point on the steep rocky hillside of the south bank. This same steep hillside down to the river would have made landing a rowed craft very difficult and movement of a ferryboat upstream impossible. What seems most likely is that the Original Ferry Site continued to be used as the Upper Ferry Crossing when separate high and low water crossings were used between 1873 and 1898. When a cable crossing was planned, a more suitable location for that type of operation was probably found farther upstream at what is now known as the Main Ferry Site. It is possible that evidence of the Original or Upper Ferry Crossing will never be found. If it indeed was located where Crampton and Rusho indicated, subsequent mining activities by Charles H. Spencer would most likely have obliterated it. However, it is possible that the presence of a ferry landing might be found opposite on the south bank.

CHAPTER 4

STABILIZATION

Site Condition

The structures at the Main Ferry Site are in poor condition. Though Structures 1 through 5 consist of partly intact walls, the remaining 10 structures vary from rubble mounds and fragmentary rock alignments to mere depressions or leveled areas. Overall, there are few standing remains, with the site's integrity having been heavily impacted from ongoing use of the area since the abandonment of the ferry operation.

The prestabilization assessment of the five standing structures found them to be relatively stable, though several problem areas were noted. However, during the removal of the previous stabilization mortar in Structures 1 and 2, it became apparent that these structures were more unstable than originally determined. The previous stabilization work seemed to have been largely cosmetic; several structural weak points had been left uncorrected. The three dry-laid structures were stable and had not been previously stabilized. The remaining structures and features at the site were stable since they have deteriorated to grade, precluding any further deterioration.

The Main Ferry Site is in an open and unprotected location. Some of the structures are constructed on uneven or sloping terrain, and all are subject to weathering impacts. Given the site's exposed location, one would attribute much of the site's deterioration and poor condition to weathering factors. However, it is suspected that a great deal of the deterioration and material loss can also be attributed to human intervention. It has been documented that two structures at the Main Ferry Site were destroyed in 1959 by the USGS (Crampton and Rusho 1965). From the information available it would appear that Structures 1 and 2 were the buildings involved. Whether any of the other structures at the site were deliberately obliterated, vandalized, or altered by human use; or have deteriorated through natural attrition is not known. It is also evident, that given the period of use of the Main Ferry Site, the occurrence of artifacts is well below what would be expected. According to Jon Dick, NPS District Ranger, removal of possibly significant historic artifacts was inadvertently authorized during an NPS clean-up of the site several years ago (Dick 1985:personal communication). The absence of previously observed prehistoric ceramic sherds was also recently noted at the site by NPS personnel. A moderate amount of recreational visitation by both tourists and fishermen has contributed to the general degeneration of the site. Unintentional disturbance of the structural remains as well as the scattering of recent trash have resulted from this use. Rodent activity caused considerable damage in one or two walls of Structures 1 and 2 but generally has not been a major problem. All these agents of deterioration are ongoing and will continue to act upon the site, regardless of the stabilization work.

Stabilization Methods

The stabilization work at the Main Ferry Site of Lee's Ferry was conducted according to the stipulations provided in the Statement of Work, Modification No. 4 of NPS contract CX-1200-3-A074. In addition to the five structures earmarked for stabilization in the scope of work, another structure identified during the recording procedures was also stabilized.

After completion of the prestabilization documentation, the stabilization work was initiated. Removal of all the old, amended mortar was undertaken at Structures 1 and 2. In some instances, the previous stabilization mortar, apparently a mixture of Portland cement and local sediments, was very friable and easily removed; in other cases it had to be broken, using the pointed end of a rock hammer or chisel, before it could be removed from the wall. Most of the amended mortar was shallow; its removal exposed holes within the wall core and voids with the wall joints. In some cases, the removal of the amended mortar loosened the wall stones, creating a precarious situation that required immediate temporary wedging until the wall was restabilized. The removal of stabilization mortar also required chipping and scraping away remnants that adhered to the rock surfaces. In a few small areas where the amended mortar had soaked into the adjacent rock, it could not be totally removed without resulting in damage to the rock surface. All cement removed from the walls was hauled off the site and disposed.

Mortar used during the 1985 stabilization was derived from locally occurring sediment sources. Description of the stabilization mortars and procedures used to develop them are discussed below in the "Mortar Design" section. Sediments were mined from two different locales within the site area. Only those areas void of structural remains or cultural deposits were considered. Inclusions used in the mortar mix were gathered from the surface of the adjacent slopes and the drainage south of Structure 2. Both unamended and amended (Rhoplex E-330) mortars were used. Water for mortar mixing and curing was obtained from the river, and stones were obtained from the surrounding area. Rubble within the site, but no longer in structural context, was used in the few instances where building stones were necessary. Chinking stones were collected at random around the site. Backfill sediments were obtained from a slope above the structures, near the mortar source, and stones used in the backfilling procedure were gathered from the surrounding site area.

No specialized equipment or logistics were necessary to complete the stabilization work. Tools and materials were hauled in and out of the site by foot. An established fishing trail provided access to the site from the parking area to the north.

Stabilization forms documenting all the work and materials used were completed for each structure on a wall-by-wall basis. These are included in Appendix A of this report. Table 6 summarizes the labor and material expenditures for completion of the stabilization work. Stabilization activities at the site involved repointing, newlaying, wedging, resetting, drainage contouring, and backfilling. Table 7 presents a summary of the work activities performed at each structure. These are standard

TABLE 6
SUMMARY OF STABILIZATION ACTIVITIES
LEE'S FERRY/MAIN FERRY SITE

Location	Repointed	Mortared Core	Relaid	Newlaid	Reset	Wedged	Backfilled	Drainage Contoured	Other
Structure 1	X	X	X	X		X	X		X ^{1,2}
Structure 2	X	X	X	X	X	X	X	X	X ^{1,2,3,4}
Structure 3				X		X	X		
Structure 4			X	X		X		X	
Structure 5			X	X		X	X		
Structure 8							X		X

¹Removal of previous stabilization mortar

²Caliche removal

³Vegetation removal

⁴Dismantled previously constructed walls

TABLE 7
SUMMARY OF STABILIZATION
MAN-HOUR AND MATERIAL EXPENDITURES
LEE'S FERRY/MAIN FERRY SITE

Work Area	Man Hours (hours:minutes)	Mortar/Sediment (cm ³)	Water (liters)	Stone (number)
Structure 1	107:11	524330	101.77	152
Structure 2	80:00	160210	22.00	221
Structure 3	2:19	9460	-	21
Structure 4	6:35	61490	-	76
Structure 5	4:56	94600	-	67
Structure 8	:35	151360	-	-
General Site	184:20*	-	-	-
Total	385:56	1001450	123.77	537

*Includes documentation

stabilization procedures and have been previously described in the Year I report. For an explanation of these tasks and the steps necessary to complete them, the reader is referred to this earlier report (Metzger et al. 1985a:21-22).

One specialized task necessary during this project was the removal of caliche that surfaced on the stabilization mortar. Because of the occurrence of salt deposits within the surrounding soils, the stabilization mortar derived from these soils also contained these salts. As the drying process progressed, caliche accumulated on the surface of the mortar, whitening the exposed surface (Figure 24). These deposits took the form of both loose salt crystals, which sat atop the surface of the mortar, and hard white deposits within the outer surface of the mortar. The former was easily removed by lightly brushing with a paintbrush or whisk broom. This procedure was carried out several times during the drying process, removing the crystals as they formed. The later caliche-like deposits that hardened within the mortar did not tend to surface until the final drying, nor were they friable enough to remove by brushing. Since they dried into the surface of the amended mortar, these white deposits were not removable without scraping away the surface of the mortar itself. Through experimentation, it was found that by periodically spraying the surface of the mortar as it dried, the salts could be washed out before becoming permanently set into the wall. A Hudson spray can was used for this purpose, providing an intense spray with which to wash down the walls. The procedure was completed several times per wall. In most cases, the problem was remedied by these procedures (Figure 25). Some lightening of the mortar color was noted in some areas, but this did not affect the structures' overall appearance.

Upon completion of the stabilization tasks, the mining areas for mortar and backfill sediment were reclaimed, as were the trail areas created in repeated hauling of the sediments to the work areas. In general, traffic across the site was confined to as few trail areas as possible to minimize impacts to the ground surface. Numerous trails from fishermen and tourist use were already present at the site. The only new trails created were in association with sediment hauling. These were swept and raked, blending them in with the surrounding areas. No attempt was made to obliterate other trails within the site since they existed prior to the stabilization work and would continue to receive repeated use. Footprints were swept from within the structures' interiors and in the heavy use areas.

Mortar Design

Before beginning the stabilization work, the stabilization mortar design needed to be developed. The historic mortar types in Structures 1 and 2 were examined; samples were collected and reconstituted for creating test patties. The color, texture, and inclusions of the historic mortar types were determined. Field methods used in completing this analysis (spit and roll, Munsell colors, etc.) are standard procedures for Nickens and Associates' stabilization. The reader is referred to the Year 1 stabilization report (Metzger et al. 1985a) for a detailed discussion of these procedures. With this information in hand, the surrounding soils were examined to find a suitable sediment source for

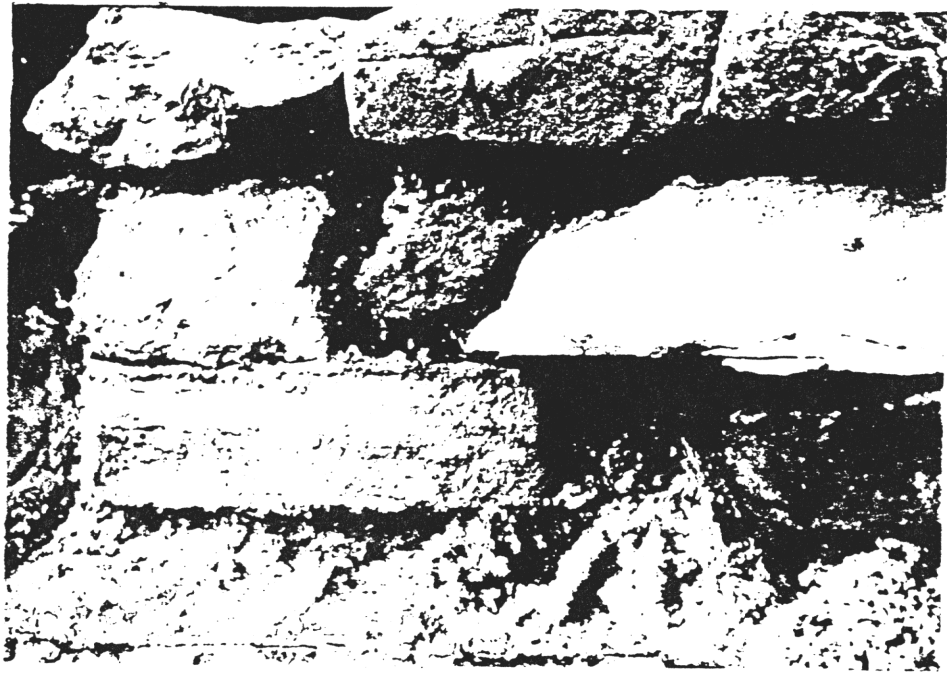


Figure 24. Structure 2, north fireplace; caliche accumulation on stabilization mortar surface during drying.



Figure 25. Structure 2, north fireplace; after spraying and brushing for caliche removal.

the stabilization mortars. Several areas were sampled, and test patties were made for comparison with the historic mortar. Despite the extent of loss, or replacement of the historic mortar by the previous stabilization mortar, our intent was to match the original mortar as closely as possible in order to reestablish the integrity and aesthetic quality of the structures.

The majority of the original mortar remaining in Structure 1 occurs in the east interior wall and the south wall. The mortar type used in Structure 1 (Type A) differs from that used in Structure 2 (Type B). The only areas within Structure 2 that contain original mortar are sections along the east wall fireplaces. Both mortars vary from very friable to strongly bonded, but this variation appears to be more a function of deterioration and weathering rather than inherent properties. A moderate amount of inclusions was noted within the Type A mortar, consisting of variable-sized quartzite shatter. The occurrence of inclusions in the Type B mortar ranges from low to high, depending on location, and consist of organic materials and sandstone gravels ranging from 0.3 cm to 4.0 cm in diameter. Minor color variation was noted in the Type B mortar in several areas along the front of the fireplaces; patches and streaks of reddened or darkened mortar occur, apparently due to heat alteration and deterioration. There were also instances where the mortar surface color differed greatly from the interior color. This also can be attributed to heat discoloration and weathering.

Two sediment areas were located as a source for the stabilization mortars (See location on Map 1, map pocket). Source area 1 was chosen to match the Type A mortar, and source area 2 to match Type B. However, four stabilization mortar types were used during the work: Types Ia, Ib, II, and III. Table 8 presents these stabilization mortar types and the sediments used to create them. Type Ia and Ib, used in Structure 1, represent amended and unamended versions of the same mortar type. Types II and III were used in Structure 2. Type II is an amended mortar mixed from sediments in source area 2, and Type III is an amended mixture of source area 1 and source area 2 sediments. This additional mortar type was developed to achieve a closer color match with the mortar on the west side of the south fireplace. Since this area appeared to be slightly redder in color than the north fireplace and was the most visible area of repair, a slightly redder color mortar than Type II was desired. Inclusions were added to each mortar mix as needed: quartzite flakes for Structure 1, sandstone gravels for Structure 2. They were mined from the adjacent slopes and south-lying drainage, respectively.

With the exception of stabilization mortar Type Ib, used in portions of the east and north wall cores of Structure 1, amended mortars were used. The mortar modifier for this project was Rhoplex E-330, a water-dispersed, acrylic polymer cement additive. According to the manufacturer's tests, mortars amended with Rhoplex E-330 exhibit superior adhesive, flexural, and abrasive resistance compared to unamended mortars and are resistant to ultraviolet light and heat. The use of Rhoplex E-330 in ruins stabilization was initiated by the NPS at Chaco Canyon National Monument in 1975 and has since been used in Aztec and Wupatki National Monuments (Steve Adams 1983:personal communication). Nickens and Associates has since used Rhoplex-amended mortars at Edge of

TABLE 8

STABILIZATION MORTAR DESIGN
LEES FERRY/MAIN FERRY SITE

Type Ia, Ib (amended and unamended mortar, respectively)
Corresponds with Type A historic mortar, Structure 1
Sediment from source area 1
Quartzite inclusions from near source area 1
Type II (amended mortar)
Corresponds with Type B historic mortar, Structure 2 north fireplace
Sediment from source area 2
Sandstone inclusions from drainage to the south
Type III (amended mortar)
Corresponds with Type B historic mortar, Structure 2 south fireplace
3 parts sediments from source area 2
2 parts sediment from source area 1
Sandstone inclusions from drainage to the south

the Cedars State Historical Monument (Matlock 1983), Canyonlands National Park (Metzger 1983; Metzger et al. 1985b; Metzger and Chandler 1986) and Natural Bridges National Monument (Metzger et al. 1985b; Metzger and Chandler 1986).

To verify the in-field mortar and sediment analysis, a professional mechanical analysis of the historic mortar samples and stabilization mortar samples was conducted. The results are outlined in Tables 9 and 10 below. Texture and particle size, Munsell soil color, electrical conductivity (EC), and hydrogen ion activity (pH) were determined. These testing procedures have been described in the Year 1 report (Metzger et al. 1985a) and will not be reiterated here. The analysis was performed by Dr. Larry Agenbroad of the Northern Arizona University Geology Department.

Structure Conditions and Stabilization

Structure 1

Condition

Structure 1 is in good condition. All four of its walls are standing at uniform height, although the upper courses and roof are missing (Figure 26). The structure appeared to be fairly stable, having been previously stabilized with amended mortar. Loose top course stones were noted, however, and several sandstone slabs along the basal courses are decomposing. Further deterioration of these stones will weaken their positioning and threaten the overlying wall. The interior face of the double stone east wall has collapsed inward exposing the mortar core. There is missing mortar and stone along the interior wall surface, which has left the overlying stones partly unsupported (Figure 27). Rodent holes are present in the interior north and east walls, and another penetrates the exterior west wall.

After removal of the stabilization mortar was completed, the stability of the structure was reevaluated. It was actually more unstable than it originally appeared, particularly along the north, east, and west interior walls. Apparently much of the previous stabilization work was cosmetic; the joints had been repointed without repairing the core or providing support for the overlying stones. Much of the weight of the walls was resting on the stabilization mortar, indicating that many of the stones and perhaps most of the interior north wall were relaid or newlaid by the earlier stabilizers. Removal of this mortar caused the east end of the interior north wall to collapse in a similar fashion to the slumped east wall. Removal of the stabilization mortar also showed rodent and insect disturbance to be more extensive than originally thought. Rodent nests were encountered within the north and west walls. The mortar core was almost entirely gone in the north, east, and west walls, creating large gaps between and behind the stones. Rodent holes and decomposing stones in the north and west walls left large areas of the surrounding wall only partly supported. This stone decomposition is expected to continue, considering the exposed location of the structure and the friable nature of the sandstone.

TABLE 9

HISTORIC MORTAR
STRUCTURAL CHARACTERISTICS
LEE'S FERRY/MAIN FERRY SITE

Type A	Type B
Particle Size %:	Particle Size %:
Sand 66.92	Sand 75.45
Silt 27.46	Silt 22.83
Clay 5.62	Clay 1.72
Texture: sandy loam	Texture: sandy loam
Color: 5YR7/4	Color: 5YR6/2
pH: 8.42	pH: 8.51
EC: 1750	EC: 5000

TABLE 10

STABILIZATION MORTAR
STRUCTURAL CHARACTERISTICS
LEE'S FERRY/MAIN FERRY SITE

Type I	Type II
Particle Size %:	Particle Size %:
Sand 67.95	Sand 62.12
Silt 27.40	Silt 34.66
Clay 4.65	Clay 3.22
Texture: sandy loam	Texture: sandy loam
Color: 5YR7/4	Color: 5YR6/3
pH: 8.95	pH: 8.43
EC: 7000	EC: 7000

Type III consists of Type I mixed with Type II, 2:3



Figure 26. Overview of Structure 1, before stabilization.

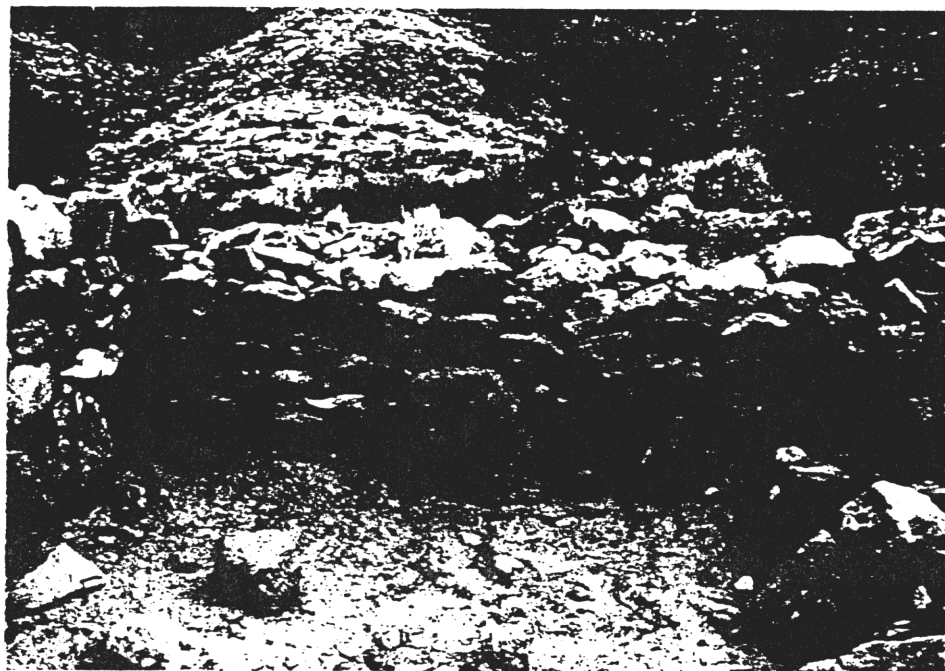


Figure 27. Interior north wall of Structure 1, before stabilization and removal of previous stabilization mortar. Note basal erosion and partly unsupported stones.

The south wall turned out to be the only relatively stable wall. This was attributed to the use of big blocky stones in the basal courses and its partly single stone construction. Much of the original mortar is still largely intact.

Stabilization

All amended mortar was removed from the walls. Most of the stabilization mortar was shallow; its removal exposed holes within the wall core and unfilled joints. The previous stabilization mortar was replaced with amended and unamended mortar. Unamended mortar was used in the west wall core and in the western portion of the north wall core. Amended mortar was used for the remaining repairs: the south and eastern north wall core areas, the top surfaces of the mortar core, all stonework, and repointing. In general, the amended mortar was used along the exposed surfaces and weakened portions of the wall - areas which needed additional structural strength. Every effort was made to fill all voids within the wall core, although in some cases access to the core was limited to small gaps between the stones through which the mortar was worked, a little at a time. In some instances, stones were added to the core to reduce the amount of mortar needed and increase the stability. Once the wall core and recessed areas were filled, the joints were repointed. In most cases, the top course stones were left as dry-laid stones since it was questionable as to whether or not they were in their original location. The top surface of the mortar core was contoured to allow for drainage toward the exterior of the wall rather than down into the wall. Dry-laid stones were added along the top of the wall to serve as dripstones, deflecting precipitation away from the core and off the wall. Along the wall faces, all mortar work was recessed to suggest a weathered appearance and to duplicate the few remaining historic mortar joints that were visible. Once dry, the mortar surfaces required repeated brushing and spraying to eliminate caliche build up along the joints.

North Wall: All previous stabilization cement was removed. The core was filled with mortar; most of the core areas required mudding. The wall was 100% repointed. Along the interior west basal area, four stones were newlaid into a hole to support the overhanging, partly unsupported stones above. The east end of the interior wall face, which had slumped along a 3.5 foot section during stabilization, was rebuilt by relaying and newlaying stones up to the previous wall height. The placement of the previously used amended mortar and the nature of the stonework suggested that the wall may have also been rebuilt by the earlier stabilizers. Due to the deteriorated nature of many of the stones and the construction methods used, the exact construction could not be duplicated and still provide for a stable wall. New stones were used; however, the general construction style and appearance of the wall prior to slumping were maintained. The stones were dry-laid/mudded and wet-laid into place. After the wall was repaired, a few stones were piled along the base in a rubble-like manner for additional protection and support.

On the exterior, in addition to cement removal and repointing, three areas required newlaid stones. Small stones and chunks were newlaid into the basal vertical joints to help support the overlying stones and secure the mortar.

The exposed top surface of the core was covered with amended mortar contoured so as to allow for drainage off the wall rather than down into the core. Stones were dry-laid on top of the wall to deflect precipitation.

East Wall: On the interior, all cement was removed, the inner core of the south half of the wall was filled with amended mortar, and 75% of the wall joints were repointed. The north end of the wall had previous slumped along the inner face, exposing the mortar core. This was wetted down then covered with sediment and dampened again to compact the sediments and increase adherence. Stones were randomly placed on top of the exposed mortar where possible to minimize the surface area exposed to weathering.

The exterior wall surface was 100% repointed after the previous stabilization cement was removed. Two small stones and three large stones were reset, and six others were newlaid to fill larger gaps in the wall surface.

The top of the wall was protected by adding dry-laid stones across the core to deflect precipitation. The top surface of the mortar core was contoured to allow for drainage off the wall and to prevent water from sitting and seeping into the core.

South Wall: Only a small amount of amended mortar was removed from this wall surface; much of the original mortar still remained. Approximately 30% of the interior and 25% of the exterior wall surfaces were repointed, most of which involved overpointing on top of the recessed historic mortar. Along the exterior eastern portion of the wall, two small rodent holes were cleaned out and filled with mortar. A gap in a vertical joint at the west end of the wall was repointed, adding a chunk and a spall for additional support and to further distribute the mortar. Along the top west half of the wall, the exposed historic mortar was moistened and then covered with dampened sediment. A few dry-laid stones were placed on top of the exposed mortar areas to deflect precipitation. A small area of exposed mortar core on the east half of the wall was covered with amended mortar and contoured to allow for drainage of the top of the wall rather than down into the core.

West Wall: Once the previous stabilization mortar was removed, the core area was filled with amended mortar and the joints 95% repointed. One stone and three leveler spalls were newlaid in the basal northwest interior corner. Another small stone was newlaid above a decomposed basal stone at the south end of the wall to fill the gap created by the stone loss. On the exterior, five small stones were newlaid in gaps caused by decomposed stones.

Other: The interior floor area was backfilled, particularly along the north and west walls. This was done to minimize differential interior and exterior fill levels and to provide additional support along the wall bases. Backfill sediment was added to the exterior east and south wall bases for the same reason. The area within the entryway was backfilled to help prevent further downslope movement of fill out of the structure due to foot traffic. Large stones were placed outside the entryway to brace the fill.

Structure 2

Condition

Structure 2 is in poor condition; all that remains are the two fireplace areas of the east wall. The north wall is missing and the two low masonry walls that comprise the south and west walls are, in fact, not original but the work of the previous stabilization crew (Figure 28). What does remain of the original structure appears to be stable. The standing courses have been stabilized with amended mortar and are secure. A few loose top course stones were present along the existing south and west walls, however. Gaps were noted extending into the interior of the south fireplace due to mortar loss, and the mortar facing along the front of the fireplace is eroding. Minor foundation erosion was evident along all the walls, and there is a rodent hole along the exterior west wall base, although this deterioration is not posing a threat to the structure.

Due to the structure's open location, exposure to weathering is the primary cause for deterioration. Direct precipitation, intense sun and wind, and the associated temperatures changes are all active factors affecting the structure's condition.

Once the stabilization mortar was removed from the walls, it became apparent that the structure was not as sound as originally presumed. The previous stabilization work, while correcting the instability in some areas, was largely cosmetic in others. Joints had been repointed without filling in the core areas or wedging the overlying stones. A rodent hole was found in the southwest interior corner extending deeply within the base of the wall. This hole had been covered with amended mortar as a facade, but not filled. Along the west exterior wall, stones which were not being supported by the underlying basal stones were mudded in place with thick beds of amended mortar. With the stabilization mortar removed, these stones became loose. In general, the stabilization mortar was supporting much of the weight of the walls. Little attempt appears to have been made to fill the inner core areas. It seems likely that stabilization along the west side of the south fireplace involved some rebuilding and new building in an attempt to support the chimney portion.

Stabilization

North Wall: No stabilization work was performed on this wall, as there are no structural remains.



Figure 28. Overview of Structure 2, before stabilization and removal of previous stabilization mortar.

East Wall: All previous stabilization mortar was removed from this wall and replaced with Rhoplex E-330 amended mortar. All voids created and exposed by the mortar removal were repaired.

Along the north side of the north fireplace, in addition to re-pointing, three small stones were newlaid within a basal hole and one medium-sized stone was added to wedge a partly overhanging stone. The east side of the north fireplace required only minor repointing, as most of the original historic mortar was still intact. One large stone was placed (dry-laid) on the top course to protect the exposed mortar joints below, and a large stone was wedged and repointed in place near the base of the wall. Several stones were placed at the base of the wall in a rubble-like fashion to provide additional support and protect the area from foot traffic and foundation erosion. Minor repointing was completed on the south side and interior of the fireplace and an extensive amount of repointing was performed on the west side. One large stone and three small stones were newlaid within the interior for the repair of several small cavities. The mortar surface along the top of the wall was contoured so as to promote drainage off the wall rather than seeping into the core. The top course stones were not repointed in place but left dry-laid, as they were situated securely on the wall as is. Along the south side of the fireplace, a few stones were dry-laid atop exposed mortar joints to prevent precipitation from contacting the mortar.

The south fireplace also required repointing with amended mortar. A minor amount of repointing was necessary along the north and east sides; small stones were newlaid within the walls to fill a few small cavities. The south side of the fireplace required more extensive work; large holes created by rodent burrowing along the basal courses were filled with amended mortar and stones, and eight courses of stone in the southeastern portion required newlaying or relaying. Some of the existing stones, having deteriorated to the point where they no longer provided adequate support, were replaced with new stones. The west side of the fireplace and the interior flue area also required an extensive amount of repointing. Holes above the fireplace opening were repaired with newlaid stone and mortar. The masonry to either side of the fireplace opening was 100% repointed. To the north, a large stone on a deteriorating mortar bed was wedged with newlaid stones and repointed from below to provide a more stable foundation. In the southeast corner, several large voids within the wall were repaired with stone and amended mortar, and several stones required relaying.

The southernmost portion of the east wall, extending from the southern fireplace, was dismantled. After the amended mortar was removed, it was apparent that this section of wall had been constructed by the earlier stabilizers. The wall was broken down, scattering the stones in the vicinity in a rubble-like manner, and the foundation area was backfilled with sterile sediment.

Backfill sediments were added along the south, west, and north sides of both fireplaces to minimize continued foundation erosion. The placement of backfill will hopefully protect the foundation from foot

traffic and exposure and prevent undermining of the walls. Stones were also scattered in the backfill areas to brace the added fill and provide additional protection.

South and West Walls: Removal of the previous stabilization mortar and examination of the historic photos revealed that these walls had been built by the earlier stabilizers. It was decided to dismantle the walls in order to expose the original construction materials and foundational remains. Upon completion of this investigation, only those features consistent with the original construction were left in place. The charred upright posts and low-lying areas of the foundation outline, including the excavated area on the south wall, were given a protective covering of clean fill dirt. The rocks used to construct the walls were cleaned off, removing the amended mortar, then scattered about the structure area in a rubble-like manner.

Structure 3

Condition

The condition of this structure is fair to good, with most of its masonry walls intact (Figure 29). It is stable with no immediate problem areas apparent. The masonry of the structure is tight despite its uncoursed construction, with the exception of a few loose top course stones. What little mortar remains at this structure is very eroded, and due to the open location of the site, this erosion will continue but should not affect the stability of the surrounding stones. A 2 foot section at the south end of the west wall and a 4 foot section at the basal level of the north wall are the only wall areas containing mortar. Whether or not these walls were completely mortared at one time is not evident. The north, east, and south walls are partially subterranean on the exterior. This differential fill level is not impacting the walls adversely, however. There is some exterior fill loss on the north portion of the east wall. Water runoff can flow through the exterior basal level into the interior of the structure. Though the wall is currently intact, this condition can become more severe, eroding the foundation and causing instability and possible collapse. The interior fill is slightly deflated but causes no threat to the structure. Considerable vegetation is growing in the structure and along the exterior walls. This has not caused damage at this point. The primary impact on the site is exposure to the detrimental effects of weather.

Stabilization

North Wall: Three stones were newlaid beneath basal course stones to provide support, and two were placed in front to deflect water and thus protect exposed fill from further erosion. The basal northwest corner was wedged with a large chunk and backfilled. An unstable top course stone was also wedged. On the exterior, two small newlaid stones were used to support a midsection stone.

East Wall: Two stones were newlaid on the interior basal level just north of the large bedrock monolith to not only provide support but to prevent exterior fill from gravitating into the interior. At the



Figure 29. Overview of Structure 3 before stabilization.

same location on the exterior and at the northeast corner, seven and three stones, respectively, were newlaid to prevent fill, precipitation, and water runoff from flowing into the structure, thus undermining the wall.

South Wall: The stones on the interior wall surface were tightened (about 1% of the wall surface).

West Wall: One small stone was newlaid (dry) on the south end of the wall, third course, to support an unstable and unsupported stone.

Structure 4

Condition

Structure 4 is in good condition with three walls still standing and mostly intact (Figure 30). Whether or not there was a fourth wall along the river is unknown; no evidence of one remains. Despite its haphazard appearance, the structure is quite stable. This is partly due to the use of the large monoliths that serve to anchor portions of the wall along the steep slope. Although there are some loose basal, mid-section, and top course stones, overall the walls are sound. In some places, particularly near the river, the north and south walls have fallen to grade. The main factors threatening this structure appear to be downslope erosion and visitor impact. A large drainage already cuts toward the river near the south wall, and a small arroyo is beginning near the north wall. Water runoff has eroded a small gully around the large monolith in the northeast corner through the structure and has started to undermine a small section of the north wall. Unintentional visitor impact due to foot traffic through the structure is also possible. A well-defined foot trail cuts through openings in the north and south walls and may have been the cause for masonry loss in this area. However, the steepness of the slope in this area seems to keep visitor traffic confined to the one passage.

Inward dead load pressure from differential fill levels on the midportion of the east wall has caused the stones to slump. Despite this shifting, no loose stones were noted.

Stabilization

North Wall: The gully cut by runoff on the interior of the structure was filled with numerous stones to prevent further erosion. The eroded channel that had formed around the monolith on the exterior northeast corner was filled with numerous stones. Three medium stones were used to wedge the loose large stones abutting the monolith.

East Wall: The eroded portion of the interior east wall where it abuts the northeast cornerstone monolith was filled with newlaid stones. The eroded basal portion was filled, rubble style, with five large stones. The midportion of the interior east wall was faced by newlaying one very large stone at the base of the wall and adding other stones in a rubble-like manner and backfill sediments for further support. At the northern end of the exterior east wall, stones were newlaid simulating



Figure 30. Overview of Structure 4, before stabilization. The foot trail runs through the center of the structure.

rubble to channel water away from the northeast corner monolith. Sediments were added as backfill to complete the drainage contouring. Stone was newlaid on the top course of the east wall to deflect water runoff away from the structure's interior.

South Wall: Two medium stones were used to wedge a few large, unsteady stones on the interior. On the exterior, several stones were added as wedges to support overhanging rocks. On both the interior and exterior, loose rocks were repositioned where necessary to attain greater stability.

West Wall: No stabilization work was performed; there is no indication of a west wall at this structure.

Structure 5

Condition

This structure is in fair to poor condition. Due to the nature of the remains, it is difficult to determine the original size and appearance of the structure. Although the excavated interior of the structure is apparent, only the western portion contains intact masonry (Figure 31). What does remain is moderately stable, although its deterioration is continuing. Due to its unprotected location, it is subject to all weathering impacts; these constitute the primary cause of deterioration. The fill that forms the foundation and the surface against which the masonry walls were constructed is eroding due to exposure, leaving overhanging and loose masonry. Some masonry has already fallen inward as a result of this condition. Also, since the structure was excavated into a west-facing slope, downslope runoff is eroding the east end of the structure, causing it to recede upslope. The water then runs the length of the structure, out the west end opening, and down the trail to the north. The exterior dirt "walls" on the north and south are also eroding downslope. The presence of the trail at the west end of the dugout invites unintentional visitor impact, though actual damage from visitor use is not readily apparent at the structure. A minor amount of rodent activity was noted on the interior south wall, but the impact is minimal. Vegetation is present on the interior of the structure as well as around the exterior; however, this vegetation growth appears to be helping to stabilize the soils, serving a beneficial function.

Stabilization

North and South Walls: The interiors of these walls were wedged with stones to fill gaps and eliminate loose stones. A variety of stones was newlaid in the basal portion midsection and along both east and west wall ends of the north and south walls to provide support for the overhanging masonry. The exterior of the western wall ends, where they curved around to retain the sloping fill, were wedged and stone was newlaid under unsupported masonry, with care taken to position the stones so as to direct water away from the wall. Two large, tabular stones and some small and medium stones were newlaid in the trail area immediately west (in front) of the north wall to retain the unconsolidated fill along the sloping trail surface. Backfill sediments obtained



Figure 31 . Overview of Structure 5 before stabilization.

from the drainage south of the structure were added to the trail along the front of the structure. Both stone and sediment were added to fill basal areas along the trail that had been undermined by both foot traffic and water runoff. This work should forestall future erosion in these areas.

Structure 8

Condition

Structure 8 is in poor condition with little standing remains (Figure 32). It is stable, its sparse masonry remains having deteriorated mostly to grade. Fill has accumulated within depression to within a foot of the surrounding area. The masonry is solid and securely positioned despite its exposed location. Foot traffic is the only other factor that could affect the future condition of this structure.

Stabilization

Structure 8 was backfilled with sterile sediments to protect the remaining masonry and interior fill from the impacts of exposure and foot traffic. A layer of clean sand was placed within the depression then backfill sediments were added, filling but not obscuring the depression. Locally occurring soils were swept over the imported fill to blend it in with the surrounding area.



Figure 32. Structure 8, before backfilling.

CHAPTER 5

RECOMMENDATIONS

Maintenance and Monitoring Recommendations

As a result of the October 1985 stabilization work, each structure at Lee's Ferry was placed in a structurally sound condition. Unstable areas created by loose rocks, unsupported wall sections, and mortar loss were corrected to prevent further deterioration and collapse of the structural remains. Potential problem areas, in addition to the existing ones, were addressed; wall bases were protected with the addition of backfill sediments and wall tops with newlaid stones to help buffer the effects of continued weathering. The removal of the previous stabilization mortar was also an area of concern. All of the Portland-amended mortar was removed from the walls at Structures 1 and 2 and replaced with the more visually and physically compatible Rhoplex-amended mortar. The stabilization work was corrective, preventative, and cosmetic; the preservation of the site and its historic integrity was the primary goal.

Despite the completion of the Year 3 stabilization work, the Main Ferry Site at Lee's Ferry will continue to be subject to various agents of deterioration. The site's open setting and its location within a heavily used recreation area will continue to result in exposure to the effects of weathering and visitor use. Rodent activity and natural structural decay will also continue to influence the future condition of the site. All these agents of deterioration are active forces and, despite the stable condition of the structures at this time, future deterioration will eventually occur.

Because of the various ongoing erosional processes, the structures at the Main Ferry Site will need to be checked periodically for signs of deterioration and disturbance. Comparison with the descriptive and photographic documentation of the site compiled during the Year 3 work will enable the detection of any structural alteration or deterioration that may have taken place since that time. Loose and displaced stones, loose and separating mortar, and foundation erosion should be noted, as they indicate weak points and potential problem areas within a structure. Areas that have been previously stabilized should be carefully examined as well; these areas have proven to be susceptible to deterioration in the past and, although the problems have been corrected and the walls stabilized, the same erosional processes will continue to act upon the walls. Visible deterioration should also be assessed as to possible cause, potential affect on the structure, and the need for immediate repair. The Ruins Stabilization Evaluation/Monitoring Form (Metzger et al. 1985a) should be used for these purposes. Monitoring inspection will serve to identify the problem areas at an early stage before the deterioration becomes severe or irreversible, resulting in material loss or eventual collapse.

Although periodic maintenance is preferred, minimally, a six-month maintenance-monitoring cycle is recommended in the early spring after the rigors of winter have passed and before the tourist season begins and again in the fall after visitation begins to decrease and before the winter weather sets in. In this way, any problems that may have developed in the interim will be noted and, hopefully, corrected before the deterioration has the opportunity to advance to a more critical level.

It goes without saying that at any time that NPS personnel should be present on the site in the course of their day-to-day responsibilities or scheduled patrols throughout the area, an inspection of the site area is recommended for monitoring purposes. Periodic monitoring will allow for relatively immediate detection and correction of potential problems. The various deterioration factors influencing the site do not always occur as gradual processes. The unpredictability of such factors as vandalism, rodent burrowing, or a sudden thunderstorm does not necessarily lend itself to six-month intervals. Periodic monitoring is a cost-effective, time-efficient approach to stabilization; the sooner a problem area is recognized, the greater the chance for elimination of the deterioration before it increases and results in loss of structural integrity.

Specific problem areas that should be checked during monitoring activities at Lee's Ferry Main Ferry Site are listed below. Table 11 outlines these areas of concern on a structure-by-structure basis.

1. The stability of the top course stones throughout the structure should be checked. These stones are more exposed to visitor contact and weathering and are therefore more susceptible to displacement. Maintenance of the top course stones is important, since their loss not only reduces the intact wall remains but results in the exposure of the stones below. At Structures 1 and 2, the top course stones also protect the upper surface of the mortar core, deflecting moisture that would otherwise seep within the wall.

2. Foundation and basal courses at Structures 1 through 5 should be checked for loose and displaced stones and loss of supporting fill. Structures 1 and 2 need to be checked for mortar loss in these areas as well. Any weakening of the lower wall areas diminishes the overall strength of the wall. Undermining and loss of support will cause settling and shifting of the overlying wall and will lead to displacement and possible collapse. Evidence of rodent activity should be noted, as this most commonly affects the lower wall courses and foundation areas in the creating of holes by displacement of fill, mortar, and stone.

Monitoring should also be sensitive to the impacts of foot traffic as it affects the foundation fill. Visitor traffic around the walls tends to contribute to the movement of the unconsolidated sediments along the wall bases. At Structure 1, this has resulted in a general downslope migration of fill away from the walls and out of the structure. Although backfill sediments have been added, these need to be checked periodically to identify any critical displacement. Fill along the west end of Structure 5 needs to be monitored for the same reason.

TABLE 11
RECOMMENDED MONITORING CONCERNS
LEE'S FERRY/MAIN FERRY SITE

	Loose, unsupported, and displaced stones	Mortar loss and separation	Founda- tion erosion	Backfill sediments displaced	Wall core erosion	Drainage contouring needed
Structure 1	X	X	X	X	X	
Structure 2	X	X	X	X	X	X
Structure 3	X		X	X		
Structure 4	X		X	X		X
Structure 5	X		X	X		X
Structure 8	X			X		

Visitor traffic along the foot trail at this end of the structure could displace the supporting fill along the wall bases and eventually undermine the basal stones.

3. Mortar surfaces should be checked for signs of cracking, separation, and loss. Although amended mortar has been used in the stabilization of Structures 1 and 2, the mortar surfaces still need to be monitored should any deterioration or loss occur. This is especially important in areas of the wall where the mortar is a weight-bearing component or where it is sealing the inner wall core from precipitation and seepage.

4. Signs of deterioration due to water runoff and drainage cutting should be noted. This is especially crucial at Structures 2, 4, and 5 where downslope runoff from above is entering the structures and/or contacting the wall areas. At Structure 2, water appeared to be channeling into the structure between the north and south fireplaces in the east wall. This water action was beginning to cause deflation of the soil in this area. At Structure 4, which is located along more steeply sloping terrain, several small drainage cuts were noted within and around the structure. A channel was cutting below the center of the east wall and another along the northeast corner. In both cases, the cutting was beginning to undermine the wall stones by removing the supporting sediments. At Structure 5, downslope water runoff has impacted the eastern end of the structure but does not appear to be actively impacting the intact masonry. The stabilization activities at these structures has corrected any weakening caused by the water erosion and at Structures 2 and 4, the runoff has been rechanneled. Monitoring of these structures should be sensitive to the possible occurrence of new channel erosion and its effects on the adjacent walls.

5. The backfill sediments at Structure 8 should be checked for signs of displacement or disturbance. If necessary, new sediment should be added to help protect both the remaining masonry and any underlying cultural deposits that might exist.

6. Visitor-related impacts need to be monitored throughout the site. Much of the visitor traffic in the area of the Main Ferry Site is associated with fishing activities along the river's edge. An established trail leading upriver crosses through the site. Unintentional impacts from foot traffic (as discussed above), visitors leaning against or bumping into the walls, and visitor-related construction are possible. Vandalism could also occur in the form of graffiti and dismantling of walls. Littering appears to be an ongoing problem at the site. Evidence of these activities should be removed as soon as possible to discourage further activities of a similar nature. Care should be taken to verify the recent, as opposed to historic origins, of these disturbances, especially in the case of trash scatter.

Recommendations for Additional Historical Research

The historical research and stabilization of the Main Ferry Site at Lee's Ferry during the Year 3 work has revealed a few areas where additional work might be beneficial. The most prominent question raised by the project concerns where the Upper Ferry Landing was actually located prior to 1898. Information gathered at the Main Ferry Site indicates that the use of that location began in 1898 when a cable was placed across the river. The scant historical documentation of the ferry operation prior to 1898 does not specify an exact location for the Upper Ferry Crossing. The Original Landing would be the leading candidate for the honor; however, subsequent use of the area, especially for hydraulic mining, has probably removed any evidence that could document the presence of a landing at that location. Additional disturbance in the construction of the boat launch and the destruction of several of the historic structures at the Lee's Ferry Fort complex in the 1960s may have precluded any possibility of finding remains of a pre-1898 ferry landing on the north bank of the Colorado River. Consequently, the place to focus a search would be on the south bank, if permission could be obtained from the Navajo Nation.

Archaeological work at several of the structures at the Main Ferry Site would be beneficial in clarifying uses and dates of construction. Of primary importance would be work at Structure 1. A single undated photograph, presumably from the period of the ferry operation, identifies this structure as the "Louse House", a place for ferry passengers to spend the night. This is the only documentation concerning Structure 1 that has been found. Excavation within the confines of the structure may result in diagnostic artifacts, which might provide a chronology of use from construction to abandonment and additional information about construction details. Of most interest, excavation might provide answers to when the structure was first constructed, what purpose it might have served during the ferry operation, if it was indeed present at that time, whether the structure was used by the USGS, and if it indeed was one of the two structures razed by them in 1959.

Testing of Structure 8 might be of tremendous interest, as this appears to have served as an outhouse. If it proves to be such, it might provide an excellent assemblage of artifacts relating to activities at that portion of the site, especially at Structure 7 since no photographs or other historical documentation have been found concerning that structure. The possible outhouse depression at Structure 6, if tested, may also prove to be informative in providing an additional artifact assemblage for site and structural interpretations.

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APPENDIX A
STABILIZATION DATA SHEETS
LEE'S FERRY/MAIN FERRY SITE

(Limited Distribution)

Copies available at the following National Park Service Offices:

Rocky Mountain Region, Denver, Colorado
Midwest Archeological Center, Lincoln, Nebraska
Glen Canyon National Recreation Area, Page, Arizona

STABILIZATION ACTIVITIES
MAN-HOURS - 1
GENERAL SITE

Site Name/Number Lee's Ferry - Main Ferry Site

ACTIVITY	HOURS:MINUTES
I. Bring in and organize equipment	3:40
II. Site Documentation	
A) Photographs	16:30
B) Prestabilization Forms	12:00
C) Site Mapping	45:50
D) General Site Documentation	55:20
E) Historic Documentation	15:45
III. Procurement of Stabilizing Material	
A) Sediment Source Location	
1) Pedestrian survey, prep of test patties	6:35
2) Aboriginal mortar analysis and comparison	3:30
B) Sediment Procurement	
1) Acquisition from sediment stratum	See forms for
2) Transport from source to processing area	Structures 1 and 2
3) Transport from processing area to site	
C) Stone Procurement	See structure forms
D) Water Procurement	2:45
IV. Daily Clean Up Procedure	
A) Cleaning/Organizing Tools	3:45
B) Curing	See forms for
C) Texturing (General Site)	Structures 1 and 2
V. Site Clean Up	
A) Removal of Stabilization Equipment	2:50
B) Return Site to Natural Condition	:45
C) Removal of Cement Debris from Site	4:20
VI. Miscellaneous	
A) Miscellaneous Activities	10:45
B)	
TOTAL	184:20

STRUCTURE STABILIZATION DATA SHEET

Site Name/Number Lee's Ferry - Main Ferry Site Personnel SMC, JLM, SE, DKG, SES

Structure Number 1 Date Started 10/23/85

Date Finished 10/28/85

Structural Location

Description of Work Performed

General

All amended mortar was removed from the walls. Most of the stabilization mortar was shallow; its removal exposed holes within the wall core and unfilled joints. The previous stabilization mortar was replaced with amended and unamended mortar. Unamended mortar was used in the west wall core and in the western portion of the north wall core. Amended mortar was used for the remaining repairs: the south and eastern north wall core areas, the top surfaces of the mortar core, all stonework, and repointing. In general, the amended mortar was used along the exposed surfaces and weakened portions of the wall - areas which needed additional structural strength. Every effort was made to fill all voids within the wall core, although in some cases access to the core was limited to small gaps between the stones through which the mortar was worked, a little at a time. In some instances, stones were added to the core to reduce the amount of mortar needed and increase the stability. Once the wall core and recessed areas were filled, the joints were repointed. In most cases, the top course stones were left as dry-laid stones since it was questionable as to whether or not they were in their original location. The top surface of the mortar core was contoured to allow for drainage toward the exterior of the wall rather than down into the wall. Dry-laid stones were added along the top of the wall to serve as dripstones, deflecting precipitation away from the core and off the wall. Along the wall faces, all mortar work was recessed to suggest a weathered appearance and to duplicate the few remaining historic mortar joints that were visible. Once dry, the mortar surfaces required repeated brushing and spraying to eliminate caliche build up along the joints.

North Wall: All previous stabilization cement was removed. The core was filled with mortar; most of the core areas required mudding. The wall was 100% repointed. Along the interior west basal area, four stones were newlaid into a hole to support the overhanging, partly unsupported stones above. The east end of the interior wall face, which had slumped along a 3.5 foot section during stabilization, was rebuilt by relaying and newlaying stones up to the previous wall height. The placement of the previously used amended mortar and the nature of the stonework suggested that the wall may have also been rebuilt by the earlier stabilizers. Due to the deteriorated nature of many of the stones and the construction methods used, the exact construction could not be duplicated and still provide for a stable wall. New stones were used; however, the general construction style and appearance of the wall prior to slumping were maintained. The stones were dry-laid/mudded and wet-laid into place. After the wall was repaired, a few stones were piled along the base in a rubble-like manner for additional protection and support.

On the exterior, in addition to cement removal and repointing, three areas required newlaid stones. Small stones and chunks were newlaid into the basal vertical joints to help support the overlying stones and secure the mortar.

STRUCTURE STABILIZATION DATA SHEET

Lee's Ferry-Main Ferry Site Structure 1 Continuation Sheet

The exposed top surface of the core was covered with amended mortar contoured so as to allow for drainage off the wall rather than down into the core. Stones were dry-laid on top of the wall to deflect precipitation.

East Wall: On the interior, all cement was removed, the inner core of the south half of the wall was filled with amended mortar, and 75% of the wall joints were repointed. The north end of the wall had previously slumped along the inner face, exposing the mortar core. This was wetted down then covered with sediment and dampened again to compact the sediments and increase adherence. Stones were randomly placed on top of the exposed mortar where possible to minimize the surface area exposed to weathering.

The exterior wall surface was 100% repointed after the previous stabilization cement was removed. Two small stones and three large stones were reset, and six others were newlaid to fill larger gaps in the wall surface.

The top of the wall was protected by adding dry-laid stones across the core to deflect precipitation. The top surface of the mortar core was contoured to allow for drainage off the wall and to prevent water from sitting and seeping into the core.

South Wall: Only a small amount of amended mortar was removed from this wall surface; much of the original mortar still remained. Approximately 30% of the interior and 25% of the exterior wall surfaces were repointed, most of which involved overpointing on top of the recessed historic mortar. Along the exterior eastern portion of the wall, two small rodent holes were cleaned out and filled with mortar.

A gap in a vertical joint at the west end of the wall was repointed, adding a chunk and a spall for additional support and to further distribute the mortar. Along the top west half of the wall, the exposed historic mortar was moistened and then covered with dampened sediment. A few dry-laid stones were placed on top of the exposed mortar areas to deflect precipitation. A small area of exposed mortar core on the east half of the wall was covered with amended mortar and contoured to allow for drainage of the top of the wall rather than down into the core.

West Wall: Once the previous stabilization mortar was removed, the core area was filled with amended mortar and the joints 95% repointed. One stone and three leveler spalls were newlaid in the basal northwest interior corner. Another small stone was newlaid above a decomposed basal stone at the south end of the wall to fill the gap created by the stone loss. On the exterior, five small stones were newlaid in gaps caused by decomposed stones.

STRUCTURE STABILIZATION DATA SHEET

Lee's Ferry-Main Ferry Site Structure 1 Continuation Sheet

Other: The interior floor area was backfilled, particularly along the north and west walls. This was done to minimize differential interior and exterior fill levels and to provide additional support along the wall bases. Backfill sediment was added to the exterior east and south wall bases for the same reason. The area within the entryway was backfilled to help prevent further downslope movement of fill out of the structure due to foot traffic. Large stones were placed outside the entryway to brace the fill.

STABILIZATION ACTIVITIES
MAN HOURS - 2
SPECIFIC STRUCTURE/JOB

Site Name/Number Lee's Ferry/Main Ferry Site Structure Number 1
Personnel SMC Date 10/23/85

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
I. Structure Documentation											
A) Form Completion											
1) Stabilization Activity and Quantities Form										2:10	2:10
2) Miscellaneous Notes											
II. Preparation of Stabilization Materials											
A) Mortar Processing											
1) Sediment Mining										2:20	2:20
2) Transportation from Source to Site										:30	:30
3) Mixing and Kneading										8:15	8:15
B) Stone Masonry Acquisition											
1) On-site Source (within Ruin--reuse)		:05	:01		:10	:05			:05	:10	:36
2) Alternate Source		:05								:15	:20
3) Masonry Processing											
III. Structure/Job Preparation											
A) Assemble Stabilization Equipment at Job Location										:10	:10
B) Assemble Stabilization Materials at Job Location											
1) Stone Masonry										:20	:20
2) Mortar											
3) Water											
C) Structure Preparation											
1) Wall cleaning (removal of loose and deteriorated structural fabric)		1:10	2:00		1:15		:15	3:25	1:20		9:25
2) Shoring wall during stabilization			:10								:10

MAN HOURS - 2 Contd.

Site Number Lee's Ferry-Main Ferry SiteStructure Number 1

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
IV. Stabilization Activities											
A) Relaying				:20	:20						:40
B) Newlaying		13:20	:05		:35	:15	:05	:50	:15	:40	16:05
C) Resetting			:20		:25						:45
D) Recoursing											
E) Wedging		2:00			:05						2:05
F) Repointing		1:35	3:00	2:00	6:50	2:30	2:15	3:10	5:00		26:20
G) Pointing											
H) Remudding											
I) Replastering											
J) Painting											
K) Texturing (Caliche removal)		1:45	:45		:55			:50	:50	8:40	13:45
L) Curing		:15			:15				:15	:55	1:40
M) Drainage contouring											
N) Water Barrier Construction											
O) Backfilling										4:30	4:30
P) Miscellaneous		1:30								:10	1:40
Q) Corefilling			7:30				1:00	4:50			13:20
R) Rubble added										:45	:45
S) Newlaying stones on top course*			:25					:25			:50
V. Structure/Job Cleanup											
A) Removal of Stabilization Equipment										:30	:30
B) Removal of Stabilization Debris											
C) Return Work Area to Natural Condition											
D) Graffiti Removal											
VI. Other											
Total											
		8:05				:05		5:15			
		21:45	6:11	2:20	10:50	2:50	3:30	8:30	7:30	30:20	107:11

*Dry-laid, to cover exposed mortar surfaces

STABILIZATION MATERIAL UTILIZATION
MORTAR/SEDIMENT QUANTITIES
(Cubic cm (cm³))

Site no. Lee's Ferry-Main Ferry Site
Structure no. 1

Activity	North		East		South		West		General Struc- ture	Total
	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
I. Mortar Quantities Used										
A) Relaying			2360	1770						4130
B) Newlaying	37840			2360			2360			42560
C) Resetting				2360						2360
D) Recoursing										
E) Repointing	5900	23650	2360	11820	4730	7080	8260	44920		108720
F) Pointing										
G) Remudding										
H) Replastering										
I) Painting										
J) Core filling	40200				2360		30740			73300
II. Total	40200				2360		30740			
	43740	23650	4720	18310	4730	7080	10620	44920		231070
III. Sediment Quantities Used										
A) Texturing										
B) Backfilling									293260*	293260
C) Drainage Contour										
D) Cover features/ protect cultural material										
E) Trail work										
F) Roof coverage										
IV. Total									293260	293260
V. Grand Total	40200				2360		30740			
	43740	23650	4720	18310	4730	7080	10620	44920	293260	524330

*198660 cm³ on the interior, 94600 cm³ along the exterior.

STABILIZATION MATERIAL UTILIZATION
WATER QUANTITIES
(Liter)

Site no. Lee's Ferry/Main Ferry Site
Structure no. 1

Activity	North		East		South		West		General Struc- ture	Total
	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
I. Quantity Used										
A) Relaying			.59							.59
B) Newlaying	5.90			trace	.50		1.00	2.00		9.40
C) Resetting				trace						trace
D) Recoursing										
E) Repointing	2.36	2.50	.59	4.73	.50	1.50	2.36			14.54
F) Pointing										
G) Remudding										
H) Replastering										
I) Painting										
J) Core		3.86				.50				4.36
II. Total		3.86								
	8.26	2.50	1.18	4.73	1.00	2.00	3.36	2.00		28.89
III. Quantity Used										
A) Mortar Processing	4.72	2.36	3.10	1.89		1.62	1.89	1.89		17.47
B) Texturing		4.73							41.0	45.73
C) Curing	4.73	2.00					2.36		.59	9.68
D) Equipment Clean up										
E) Graffiti Removal										
IV. Total										
	9.45	9.09	3.10	1.89		1.62	4.25	1.89	41.59	72.88
V. Grand Total		3.86								
	17.71	11.59	4.28	6.62	1.00	3.62	7.61	3.89	41.59	101.77

STABILIZATION MATERIAL UTILIZATION STONE-MASONRY-QUANTITIES

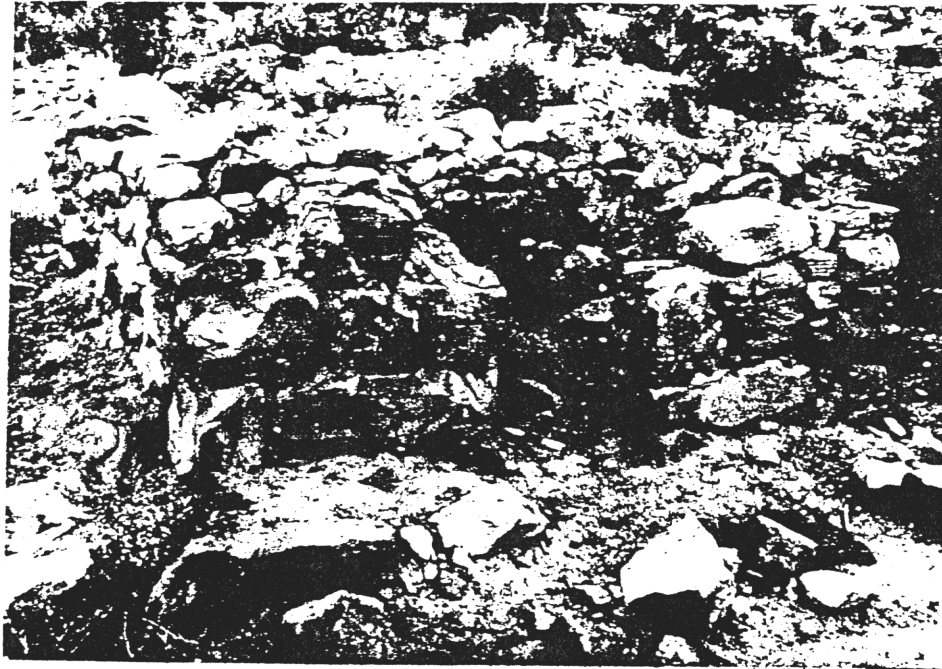
Site Number Lee's Ferry/Main Ferry Site

Structure Number 1

Structural Location Activity		North		East		South		West		General Structure	Tot			
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.					
Backfilling										X				
Relaying				X	X									
Newlaying		X	X** X		X	X	X		X	X**				
Resetting					X									
Recoursing														
Wedging					X									
Repointing			X	X	X		X							
Pointing														
Adding Rubble*			X											
Core filling			X				X							
Stone Size														
Small		5	4	6	1	9	3	1	1	9	5	44		
Medium		15	4	3	4			2		5		34		
Large		6		1	3			1	1	2		16		
Very Large					6							6		
Spall Size														
Small														
Leveler			3				1		3			7		
True							2					2		
False														
Medium														
Leveler		1										1		
True		1						4				5		
False														
Large														
Leveler														
True		4							1			5		
False														
Chunk Size														
Small		1	4					1		3		9		
Medium		9	3	2				3		2		19		
Large				1				1		2		4		
Total		42	18	13	14	9	6	4	9	5	24	5	3	152

* For additional protection along base of wall.

** Top course work.



Structure 1, overview before stabilization.



Structure 1, north wall interior before stabilization.



Structure 1, north wall interior after stabilization.



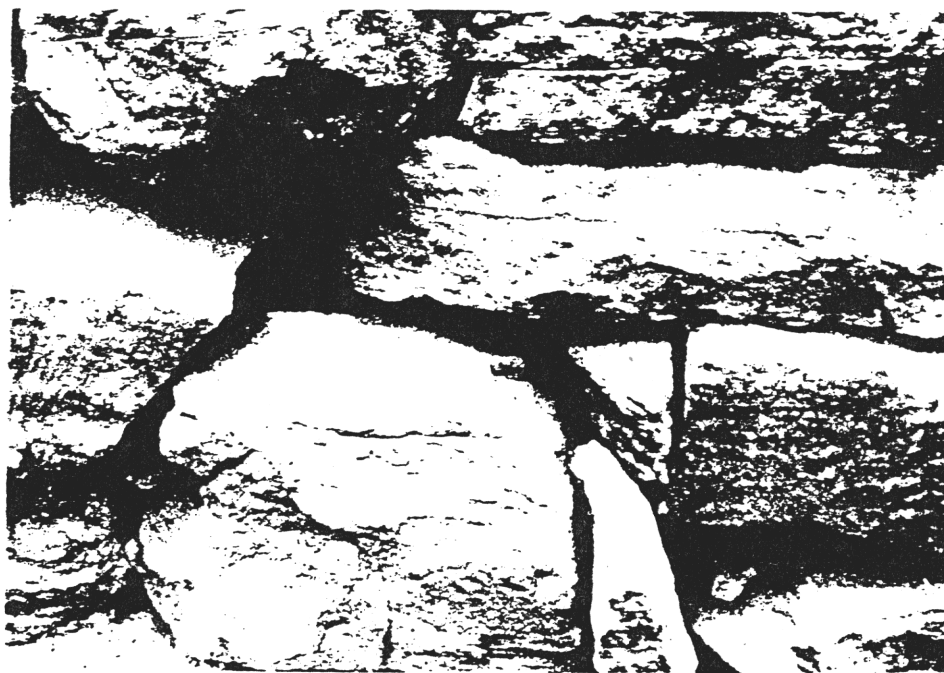
Structure 1, north wall exterior before stabilization.



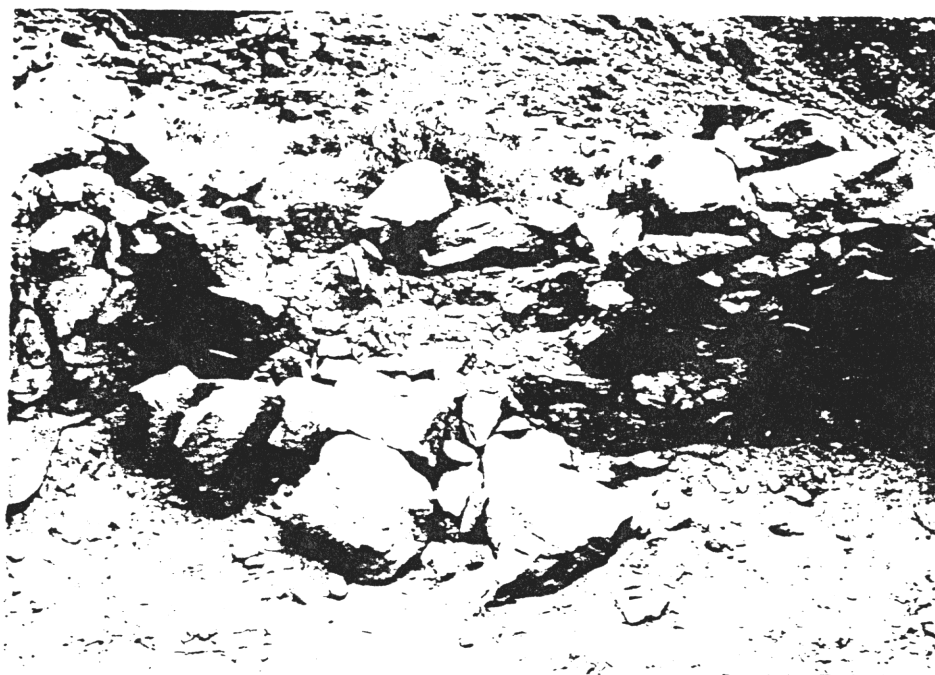
Structure 1, north wall exterior after stabilization.



Structure 1, north wall exterior showing previous stabilization mortar.



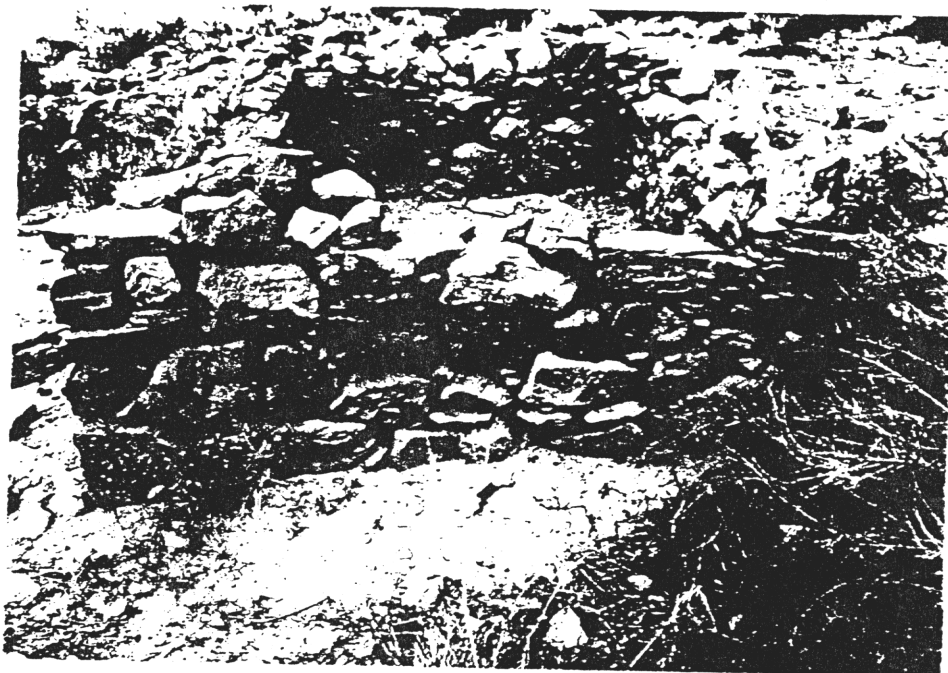
Structure 1, north wall exterior after removal of previous stabilization mortar.



Structure 1, east wall interior before stabilization.



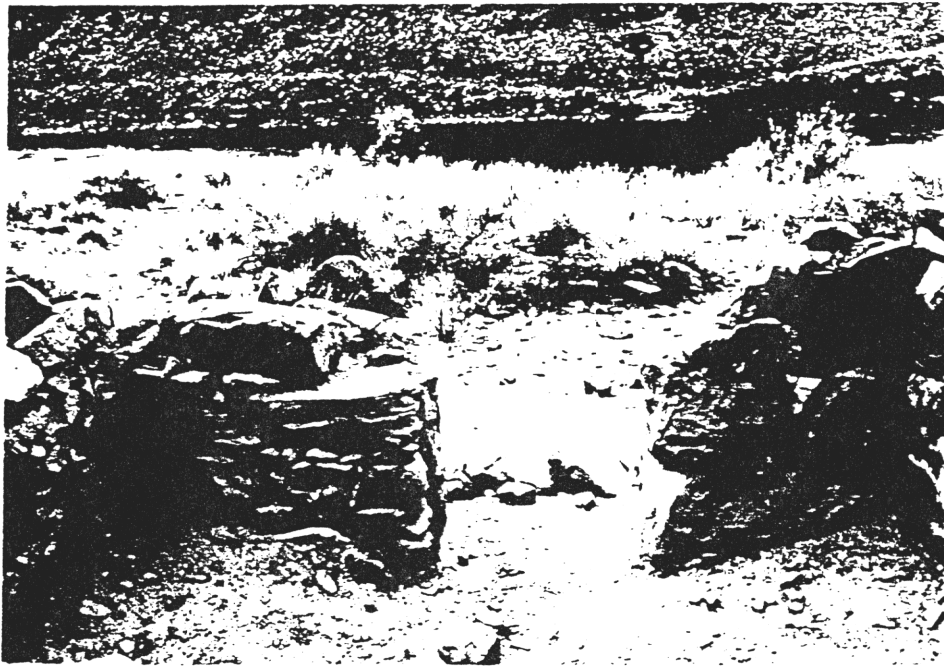
Structure 1, east wall interior after stabilization.



Structure 1, east wall exterior before stabilization.



Structure 1, east wall exterior after stabilization.



Structure 1, south wall interior before stabilization.



Structure 1, south wall interior after stabilization.



Structure 1, south wall exterior before stabilization.



Structure 1, south wall exterior after stabilization.



Structure 1, west wall interior before stabilization.



Structure 1, west wall interior after stabilization.



Structure 1, west wall exterior before stabilization.



Structure 1, west wall exterior after stabilization.

STRUCTURE STABILIZATION DATA SHEET

Site Name/Number Lee's Ferry - Main Ferry Site Personnel SMC
Structure Number 2 Date Started 10/24/85
Date Finished 10/29/85

Structural Location

Description of Work Performed

North Wall: No stabilization work was performed on this wall, as there are no structural remains.

East Wall: All previous stabilization mortar was removed from this wall and replaced with Rhoplex E-330 amended mortar. All voids created and exposed by the mortar removal were repaired.

Along the north side of the north fireplace, in addition to repointing, three small stones were newlaid within a basal hole and one medium-sized stone was added to wedge a partly overhanging stone. The east side of the north fireplace required only minor repointing, as most of the original historic mortar was still intact. One large stone was placed (dry-laid) on the top course to protect the exposed mortar joints below, and a large stone was wedged and repointed in place near the base of the wall. Several stones were placed at the base of the wall in a rubble-like fashion to provide additional support and protect the area from foot traffic and foundation erosion. Minor repointing was completed on the south side and interior of the fireplace and an extensive amount of repointing was performed on the west side. One large stone and three small stones were newlaid within the interior for the repair of several small cavities. The mortar surface along the top of the wall was contoured so as to promote drainage off the wall rather than seeping into the core. The top course stones were not repointed in place but left dry-laid, as they were situated securely on the wall as is. Along the south side of the fireplace, a few stones were dry-laid atop exposed mortar joints to prevent precipitation from contacting the mortar.

The south fireplace also required repointing with amended mortar. A minor amount of repointing was necessary along the north and east sides; small stones were newlaid within the walls to fill a few small cavities. The south side of the fireplace required more extensive work; large holes created by rodent burrowing along the basal courses were filled with amended mortar and stones, and eight courses of stone in the southeastern portion required newlaying or relaying. Some of the existing stones, having deteriorated to the point where they no longer provided adequate support, were replaced with new stones. The west side of the fireplace and the interior flue area also required an extensive amount of repointing. Holes above the fireplace opening were repaired with newlaid stone and mortar. The masonry to either side of the fireplace opening was 100% repointed. To the north, a large stone on a deteriorating mortar bed was wedged with newlaid stones and repointed from below to provide a more stable foundation. In the southeast corner, several large voids within the wall were repaired with stone and amended mortar, and several stones required relaying.

STRUCTURE STABILIZATION DATA SHEET

Lee's Ferry-Main Ferry Site Structure 2 Continuation Sheet

The southernmost portion of the east wall, extending from the southern fireplace, was dismantled. After the amended mortar was removed, it was apparent that this section of wall had been constructed by the earlier stabilizers. The wall was broken down, scattering the stones in the vicinity in a rubble-like manner, and the foundation area was backfilled with sterile sediment.

Backfill sediments were added along the south, west, and north sides of both fireplaces to minimize continued foundation erosion. The placement of backfill will hopefully protect the foundation from foot traffic and exposure and prevent undermining of the walls. Stones were also scattered in the backfill areas to brace the added fill and provide additional protection.

South and West Walls: Removal of the previous stabilization mortar and examination of the historic photos revealed that these walls had been built by the earlier stabilizers. It was decided to dismantle the walls in order to expose the original construction materials and foundational remains. Upon completion of this investigation, only those features consistent with the original construction were left in place. The charred upright posts and low-lying areas of the foundation outline, including the excavated area on the south wall, were given a protective covering of clean fill dirt. The rocks used to construct the walls were cleaned off, removing the amended mortar, then scattered about the structure area in a rubble-like manner.

STABILIZATION ACTIVITIES
MAN HOURS - 2
SPECIFIC STRUCTURE/JOB

Site Name/Number Lee's Ferry/Main Ferry Site Structure Number 2
Personnel SMC Date 10/24/85

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	North fire-place	South fire-place	Int.	Ext.	Int.	Ext.		
I. Structure Documentation											
A) Form Completion											
1) Stabilization Activity and Quantities Form				:25	:30					:15	1:10
2) Miscellaneous Notes										5:15	5:15
II. Preparation of Stabilization Materials											
A) Mortar Processing											
1) Sediment Mining				:15	:50						1:05
2) Transportation from Source to Site				:05	:15						:20
3) Mixing and Kneading				:45	3:15						4:00
B) Stone Masonry Acquisition											
1) On-site Source (within Ruin--reuse)				:10	:10						:20
2) Alternate Source				:15	:40						:55
3) Masonry Processing											
III. Structure/Job Preparation											
A) Assemble Stabilization Equipment at Job Location											
B) Assemble Stabilization Materials at Job Location											
1) Stone Masonry											
2) Mortar											
3) Water				:15	:10						:25
C) Structure Preparation											
1) Wall cleaning (removal of loose and deteriorated structural fabric)				:30	1:10						1:40
2) Cement Removal				7:30		:20	:45	:30	1:00		10:05

MAN HOURS - 2 Contd.

Site Number Lee's Ferry/Main Ferry SiteStructure Number 2

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	North Fire-place	South Fire-place	Int.	Ext.	Int.	Ext.		
IV. Stabilization Activities											
A) Relaying				:30							:30
B) Newlaying				1:30	15:40						17:10
C) Resetting				1:00	:30						1:30
D) Recoursing											
E) Wedging				:45	:20						1:05
F) Repointing				7:40	7:35						15:15
G) Pointing											
H) Remudding											
I) Replastering											
J) Painting											
K) Texturing/Caliche Removal				:50	:45	:15					1:50
L) Curing				1:00							1:00
M) Drainage contouring											
N) Water Barrier Construction										1:00	1:00
O) Backfilling										4:20	4:20
P) Vegetation Removal										:50	:50
Q) Filling Core					4:40						4:40
R) Dismantling Wall										2:35	2:35
S) Newlaying on top of exposed mortar					:40						:40
V. Structure/Job Cleanup											
A) Removal of Stabilization Equipment										:15	:15
B) Removal of Stabilization Debris (Cement)										2: 0	2:00
C) Return Work Area to Natural Condition											
D) Graffiti Removal											
VI. Other											
Total											
				9:55							
				14:55	36:00	:20	:45	:30	1:00	16:30	79:55

STABILIZATION MATERIAL UTILIZATION
MORTAR/SEDIMENT QUANTITIES
(Cubic cm (cm³))

Site no. Lee's Ferry/Main Ferry Site

Structure no. 2

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	Fire-place	Fire-place	Int.	Ext.	Int.	Ext.		
I. Mortar Quantities Used											
A) Relaying											
B) Newlaying				4730	4730						9460
C) Resetting											
D) Recoursing					2360						2360
E) Repointing				10050	18920						28970
F) Pointing											
G) Remudding											
H) Replastering											
I) Painting											
J) Filling Core					43740						43740
II. Total				14780	69750						84530
III. Sediment Quantities Used											
A) Texturing											
B) Backfilling											
C) Drainage Contour										75680	75680
D) Cover features/ protect cultural material											
E) Trail work											
F) Roof coverage											
IV. Total											
V. Grand Total				14780	69750					75680	160210

STABILIZATION MATERIAL UTILIZATION
WATER QUANTITIES

Site no. Lee's Ferry/Main Ferry Site
Structure no. 2 (Liter)

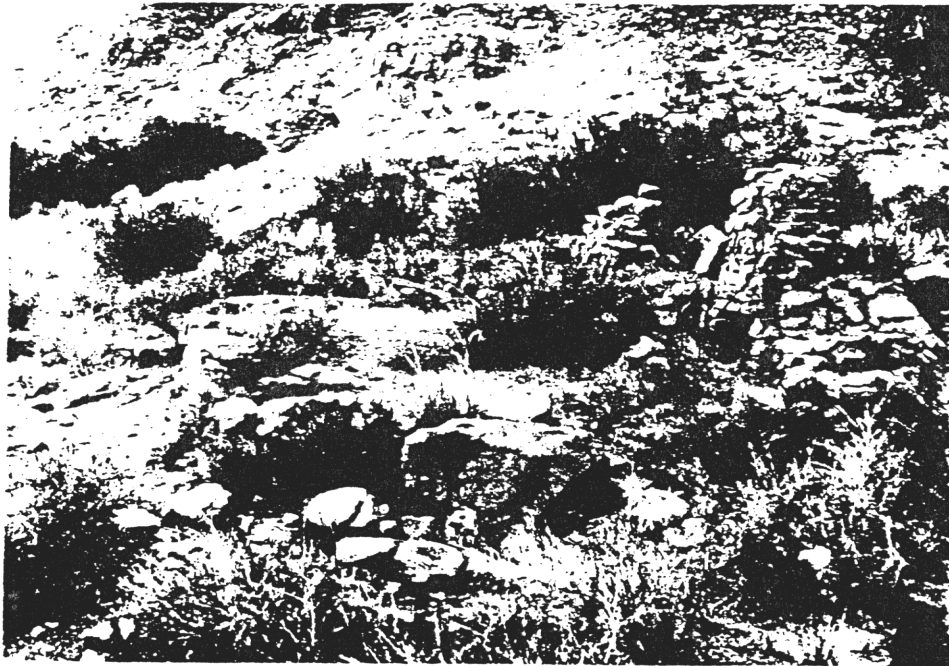
Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	North Fire-place	South Fire-place	Int.	Ext.	Int.	Ext.		
I. Quantity Used											
A) Relaying											
B) Newlaying				.22	.93						1.15
C) Resetting											
D) Recoursing											
E) Repointing				.22	.93						1.15
F) Pointing											
G) Remudding											
H) Replastering											
I) Painting											
II. Total				.44	1.86						2.30
III. Quantity Used											
A) Mortar Processing				1.05	7.30						8.35
B) Texturing											
C) Curing										11.35	11.35
D) Equipment Clean up											
E) Graffiti Removal											
IV. Total				1.05	7.30					11.35	20.10
V. Grand Total				1.49	9.16					11.35	22.40

STABILIZATION MATERIAL UTILIZATION STONE-MASONRY-QUANTITIES

Site Number Lee's Ferry/Main Ferry Site
Structure Number 2

Activity	North		East		South		West		General Struc- ture	Tot
	Int.	Ext.	North Fire- place	South Fire- place	Int.	Ext.	Int.	Ext.		
Backfilling				x						
Relaying										
Newlaying			x	x* x						
Resetting				x						
Recoursing										
Wedging			x							
Repointing				x						
Pointing										
Remudding										
Filling Core			x	x						
Stone Size										
Small			6	5	13					24
Medium			4	9	12					25
Large			4	10	5					19
Very Large				1						1
Spall Size										
Small										
Leveler			1	1	1					3
True					5					5
False										
Medium										
Leveler				1						1
True					3					3
False										
Large										
Leveler										
True					1					1
False										
Chunk Size										
Small				1	8					9
Medium			5	3	16					24
Large					24					24
Total			20	31	88					139

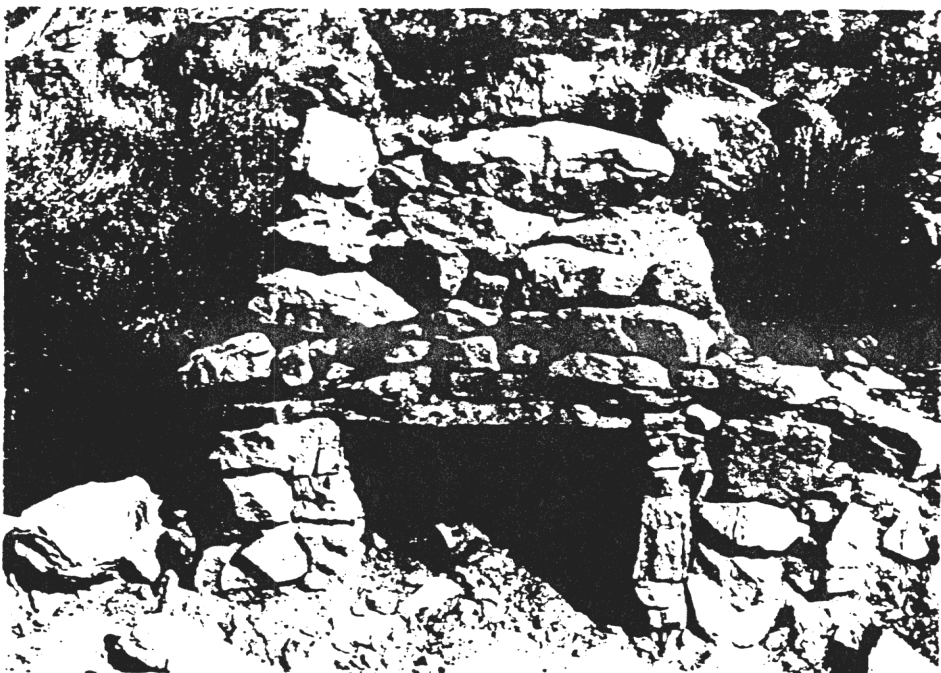
* to protect top of exposed mortar surfaces



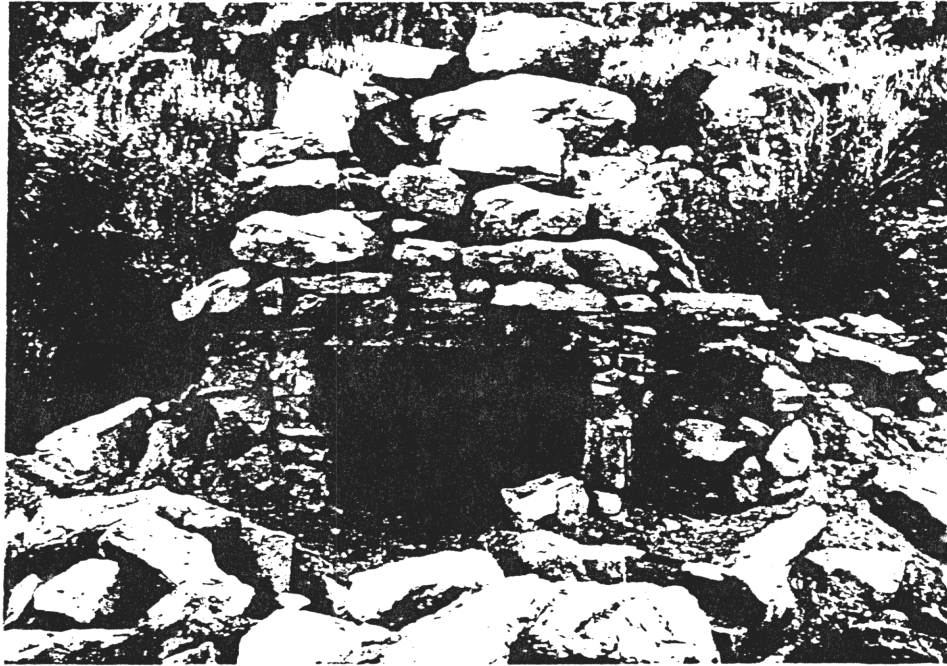
Structure 2, overview before stabilization.



Structure 2, east interior, north fireplace, before stabilization.



Structure 2, east interior, north fireplace after removal of previous stabilization mortar.



Structure 2, east interior, north fireplace, after stabilization.



Structure 2, east exterior, north fireplace before stabilization.



Structure 2, east exterior, north fireplace after removal of previous stabilization mortar.



Structure 2, east exterior, north fireplace after stabilization.



Structure 2, east interior, south fire-
place before stabilization.



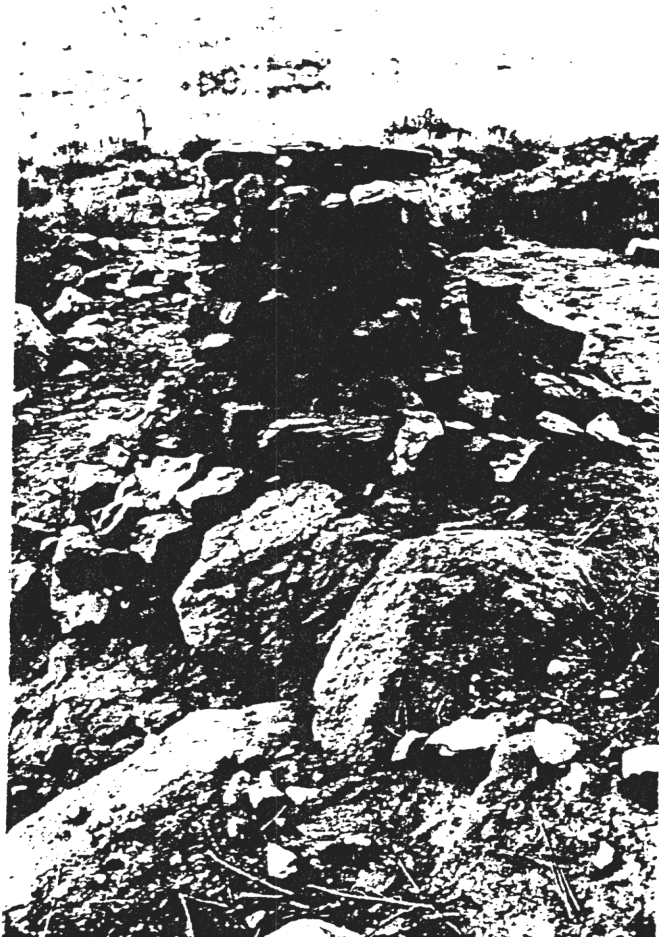
Structure 2, east interior, south fireplace after removal
of previous stabilization mortar.



Structure 2, east interior, south fireplace after stabilization.



Structure 2, southeast corner exterior, south fireplace before stabilization



Structure 2, southeast corner exterior, south fireplace after stabilization



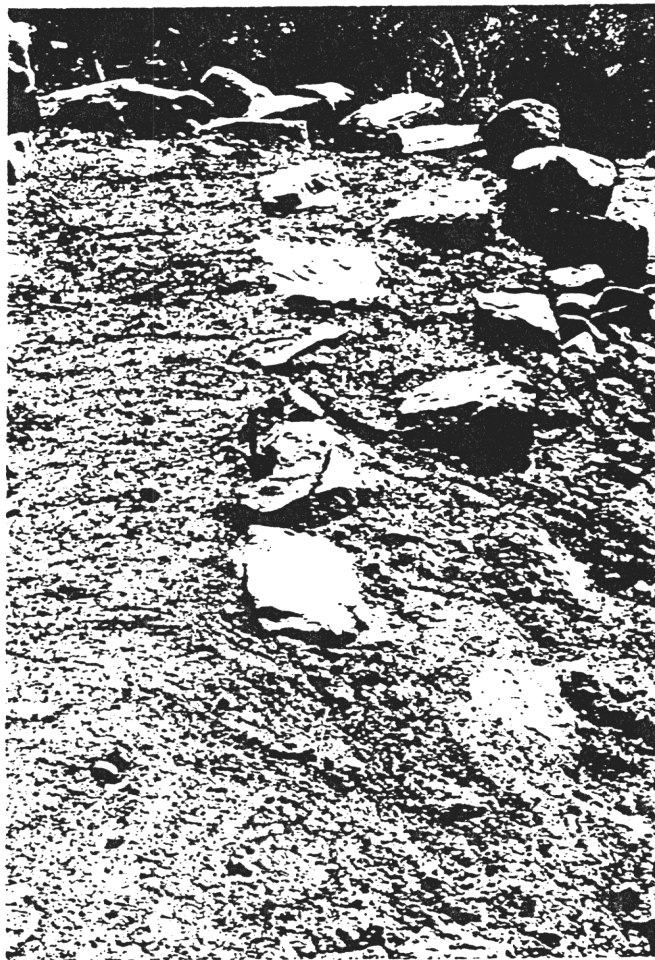
Structure 2, south interior before stabilization.



Structure 2, south interior after removal of previous reconstruction work.



Structure 2, south interior, showing charcoal stain under the reconstructed wall.



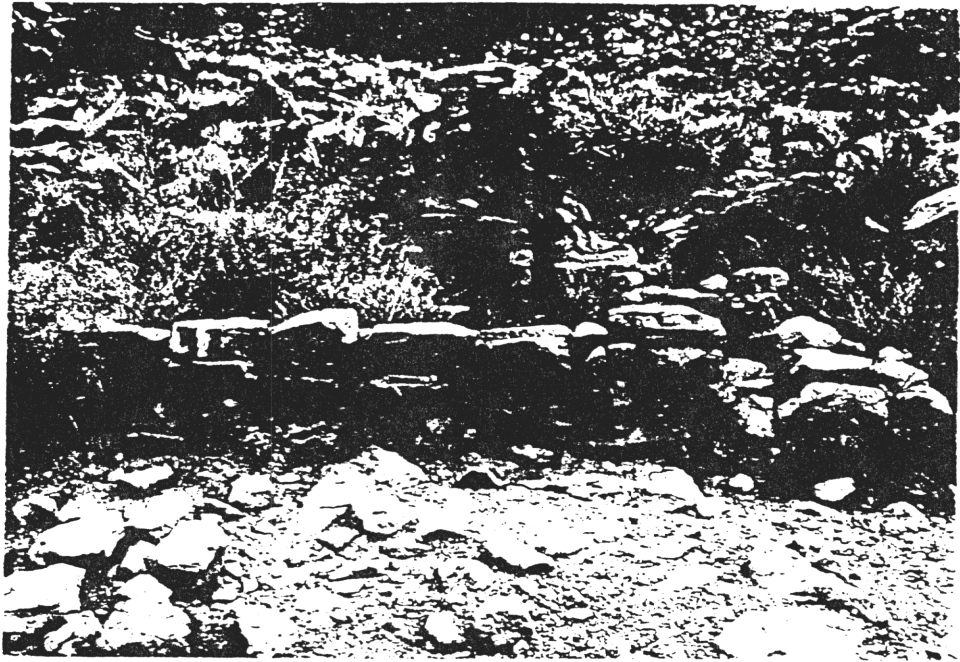
Structure 2, south and west interior after backfilling.



Structure 2, south exterior before stabilization.



Structure 2, south exterior after removal of previous reconstruction work.



Structure 2, west wall exterior before stabilization.



Structure 2, west wall showing charcoal stain under previous reconstruction work.



Structure 2, after location of west wall was backfilled.

STRUCTURE STABILIZATION DATA SHEET

Site Name/Number Lee's Ferry - Main Ferry Site Personnel JLM

Structure Number 3 Date Started 10/23/85
Date Finished 10/23/85

Structural Location Description of Work Performed

North Wall: Three stones were newlaid beneath basal course stones to provide support, and two were placed in front to deflect water and thus protect exposed fill from further erosion. The basal northwest corner was wedged with a large chunk and backfilled. An unstable top course stone was also wedged. On the exterior, two small newlaid stones were used to support a midsection stone.

East Wall: Two stones were newlaid on the interior basal level just north of the large bedrock monolith to not only provide support but to prevent exterior fill from gravitating into the interior. At the same location on the exterior and at the northeast corner, seven and three stones, respectively, were newlaid to prevent fill, precipitation, and water runoff from flowing into the structure, thus undermining the wall.

South Wall: The stones on the interior wall surface were tightened (about 1% of the wall surface).

West Wall: One small stone was newlaid (dry) on the south end of the wall, third course, to support an unstable and unsupported stone.

SPECIFIC STRUCTURE/JOB

Site Name/Number Lee's Ferry/Main Ferry Site Structure Number 3
 Personnel JM Date 10/23/85

[illegible]

MAN HOURS - 2 Contd.

Site Number Lee's Ferry/Main Ferry Site
Structure Number 3

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
IV. Stabilization Activities											
A) Relaying											
B) Newlaying		:25	:05	:15	:20			:10			1:15
C) Resetting											
D) Recoursing											
E) Wedging		:10				:05		:02			:17
F) Repointing											
G) Pointing											
H) Remudding											
I) Replastering											
J) Painting											
K) Texturing											
L) Curing											
M) Drainage contouring											
N) Water Barrier Construction											
O) Backfilling										:10	:10
P)											
Q)											
Q)											
V. Structure/Job Cleanup											
A) Removal of Stabilization Equipment											
B) Removal of Stabilization Debris											
C) Return Work Area to Natural Condition											
D) Graffiti Removal											
VI. Other											
Total											
		:40	:05 :07	:20 :05 :25	:05 :05		:17			:10	2:19

STABILIZATION MATERIAL UTILIZATION
STONE-MASONRY-QUANTITIES

Site Number Lee's Ferry/Main Ferry Site
Structure Number 3

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
Relaying											
Newlaying		X	X	X	X			X			
Resetting											
Recoursing											
Wedging											
Repointing											
Pointing											
Remudding											
Stone Size											
Small		1	2		6			1			10
Medium		3		1							4
Large		1		1	2						4
Very Large											
Spall Size											
Small											
Leveler											
True											
False											
Medium											
Leveler											
True											
False											
Large											
Leveler											
True											
False											
Chunk Size											
Small					2						2
Medium											
Large		1									1
Total		6	2	2	10			1			21

STABILIZATION MATERIAL UTILIZATION
MORTAR/SEDIMENT QUANTITIES
(Cubic cm (cm³))

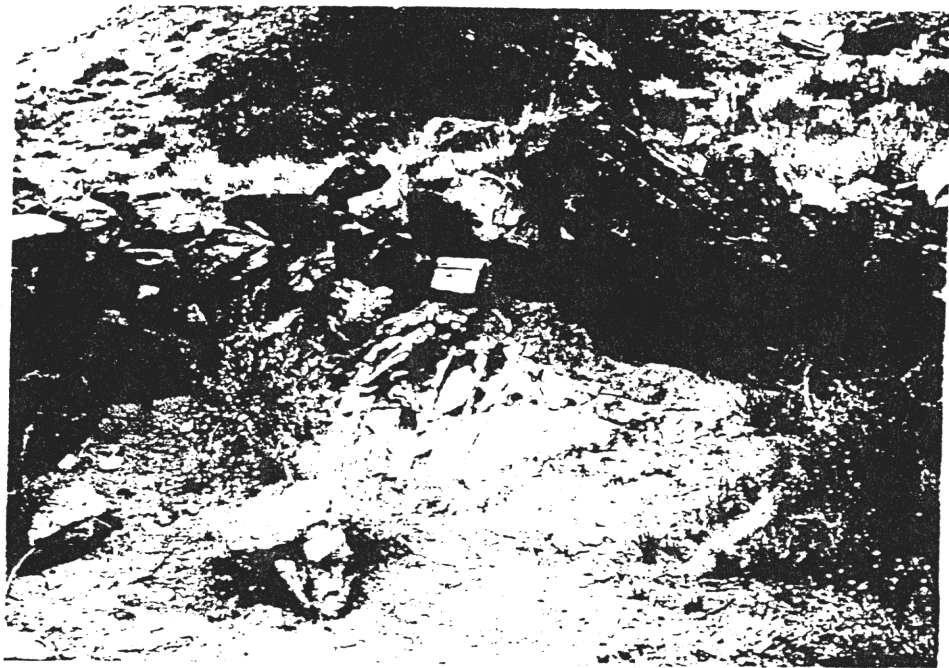
Site Number Lee's Ferry/Main Ferry Site

Structure Number 3

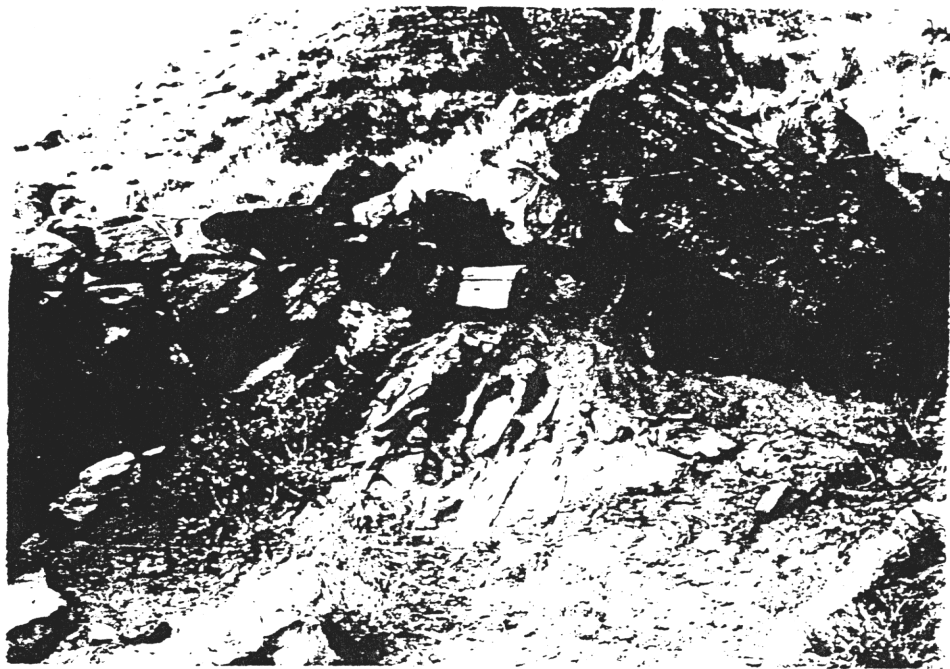
[illegible]



Structure 3, overview before stabilization.



Structure 3, north wall interior before stabilization.



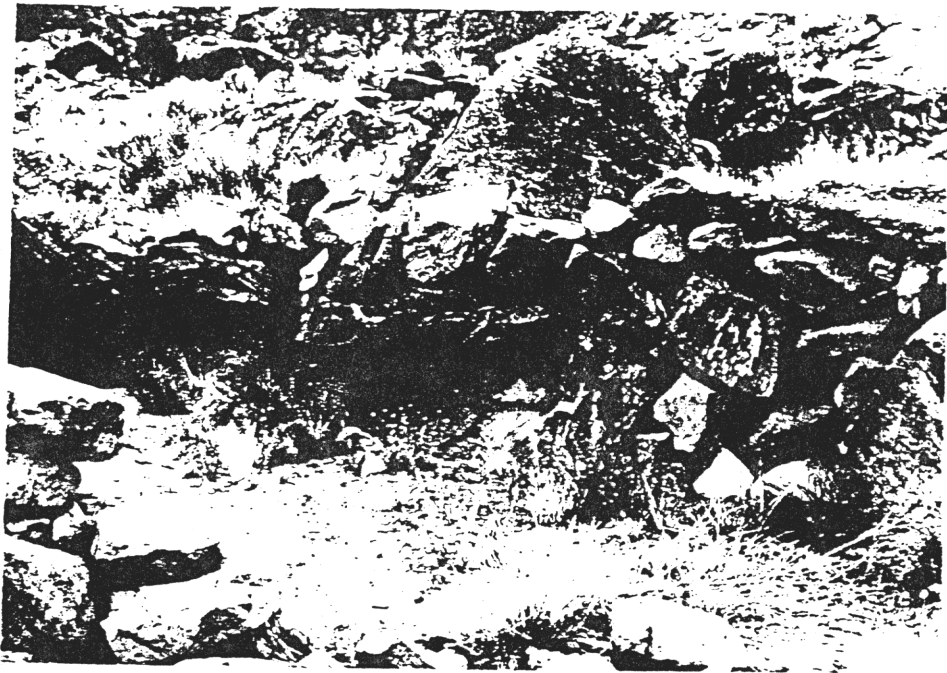
Structure 3, north wall interior after stabilization.



Structure 3, north wall exterior before stabilization.



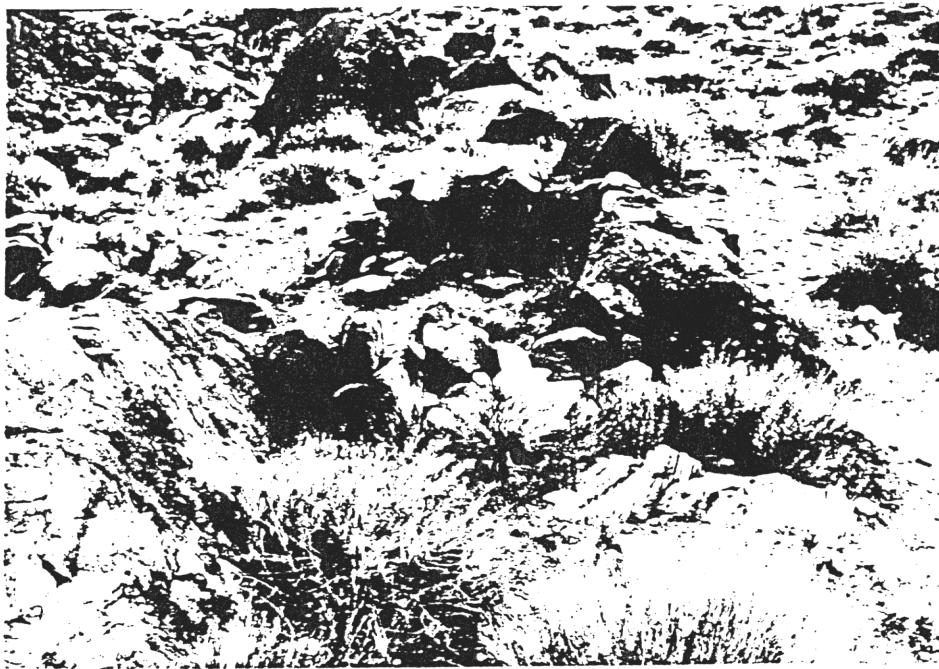
Structure 3, north wall exterior after stabilization.



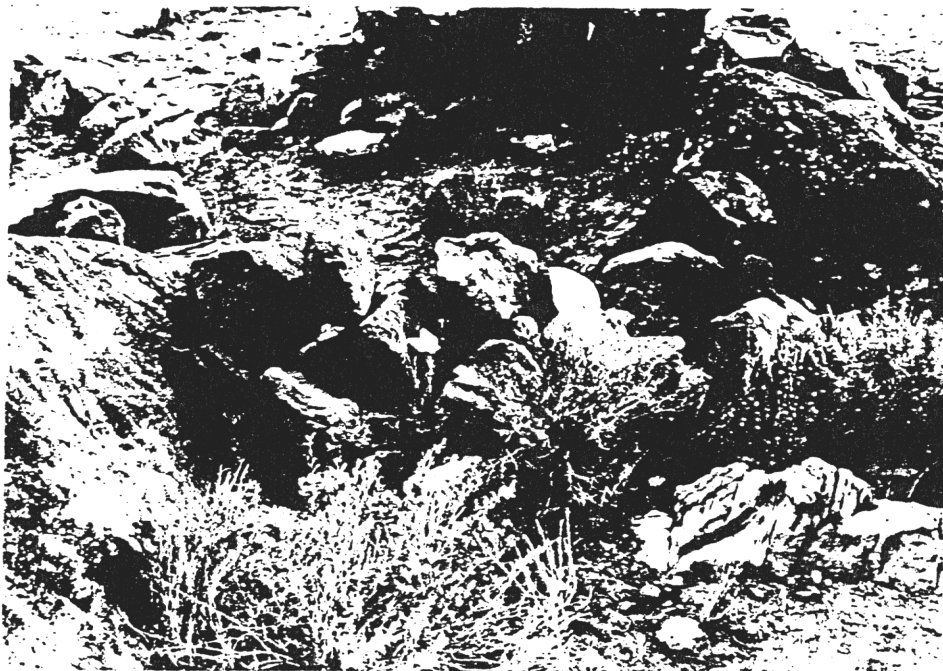
Structure 3, east wall interior before stabilization.



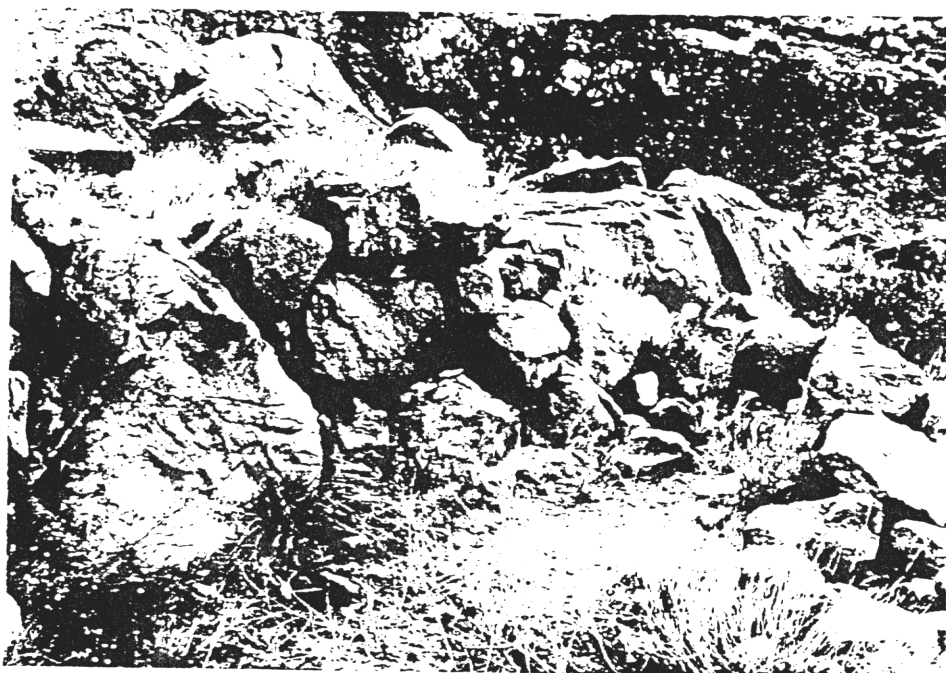
Structure 3, east wall interior after stabilization.



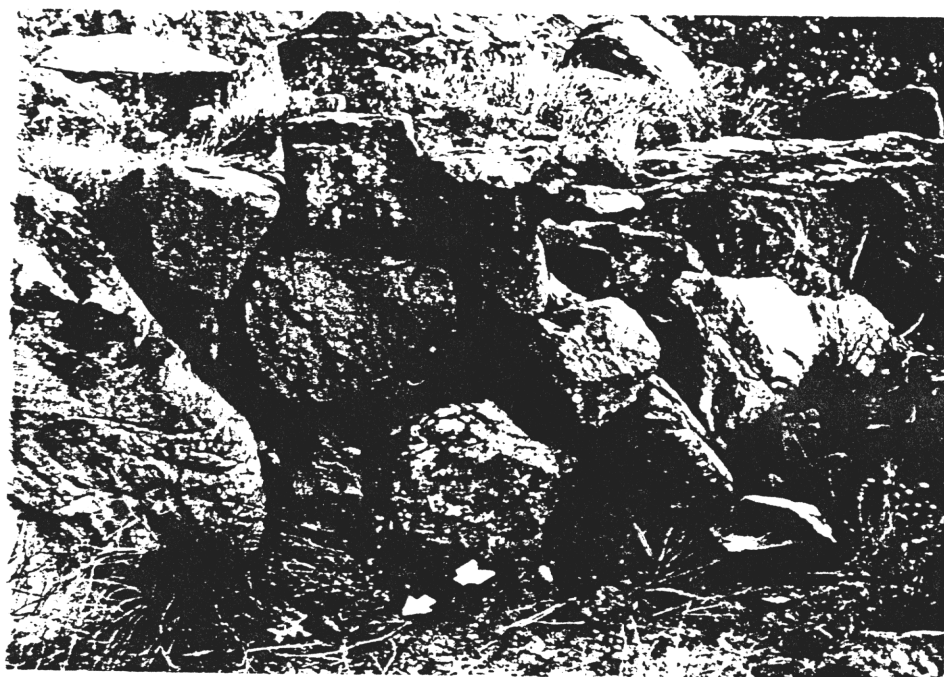
Structure 3, east wall exterior, north end, before stabilization.



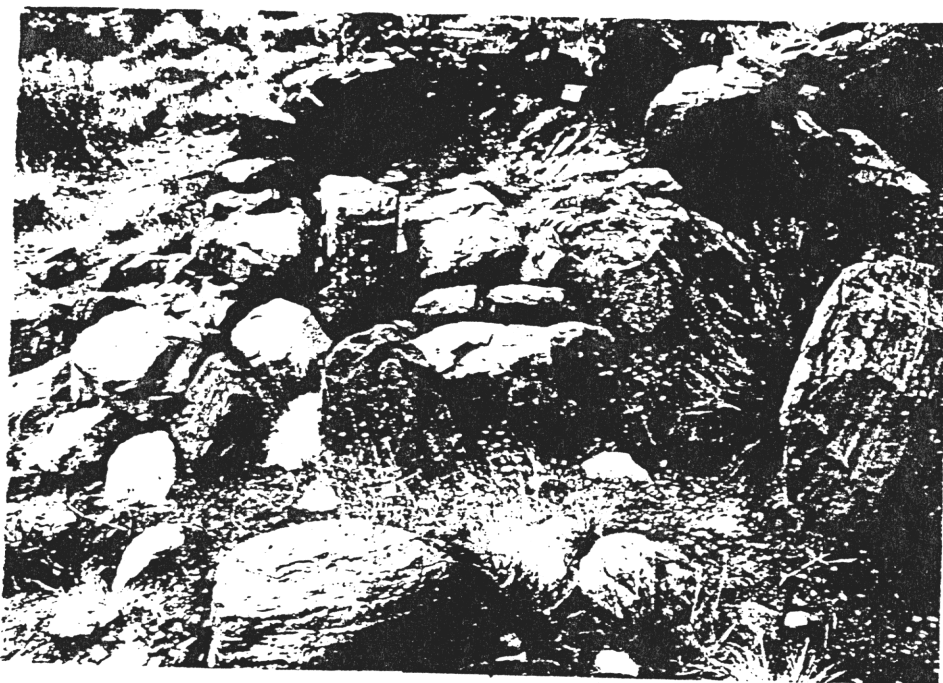
Structure 3, east wall exterior, north end, after stabilization.



Structure 3, south wall interior before stabilization.



Structure 3, south wall interior after stabilization.



Structure 3, south wall exterior before stabilization.



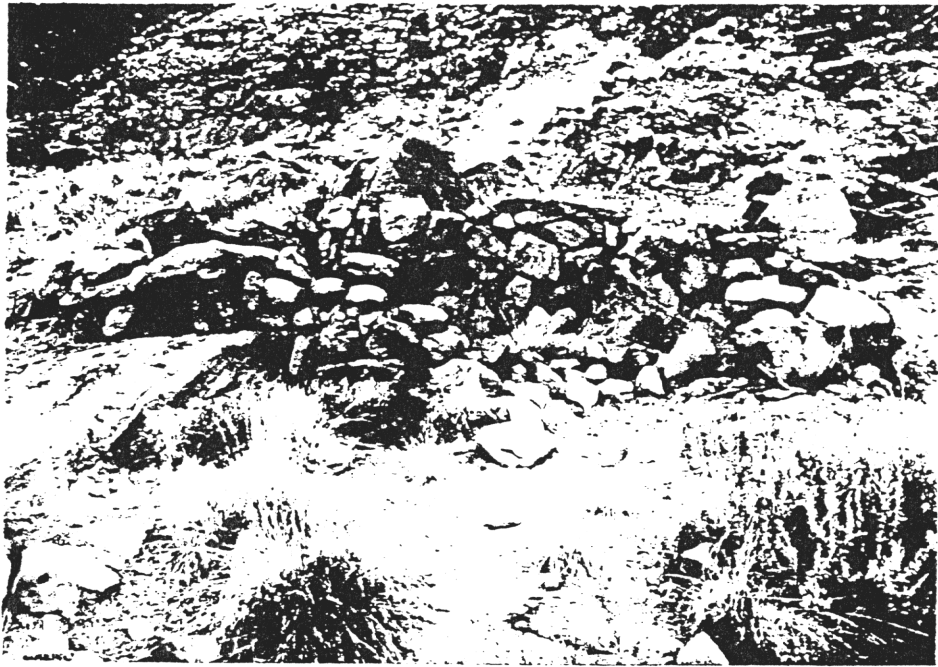
Structure 3, south wall exterior after stabilization.



Structure 3, west wall interior before stabilization.



Structure 3, west wall interior after stabilization.



Structure 3, west wall exterior before stabilization.



Structure 3, west wall exterior after stabilization.

STRUCTURE STABILIZATION DATA SHEET

Site Name/Number Lee's Ferry - Main Ferry Site Personnel DKG

Structure Number 4 Date Started 10/23/85
Date Finished 10/24/85

Structural Location

Description of Work Performed

North Wall: The gully cut by runoff on the interior of the structure was filled with numerous stones to prevent further erosion. The eroded channel that had formed around the monolith on the exterior northeast corner was filled with numerous stones. Three medium stones were used to wedge the loose large stones abutting the monolith.

East Wall: The eroded portion of the interior east wall where it abuts the northeast cornerstone monolith was filled with newlaid stones. The eroded basal portion was filled, rubble style, with five large stones. The midportion of the interior east wall was faced by newlaying one very large stone at the base of the wall and adding other stones in a rubble-like manner and backfill sediments for further support. At the northern end of the exterior east wall, stones were newlaid simulating rubble to channel water away from the northeast corner monolith. Sediments were added as backfill to complete the drainage contouring. Stone was newlaid on the top course of the east wall to deflect water runoff away from the structure's interior.

South Wall: Two medium stones were used to wedge a few large, unsteady stones on the interior. On the exterior, several stones were added as wedges to support overhanging rocks. On both the interior and exterior, loose rocks were repositioned where necessary to attain greater stability.

West Wall: No stabilization work was performed; there is no indication of a west wall at this structure.

SPECIFIC STRUCTURE/JOB

Personnel	DKG, SE	Date	10/24/85
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[illegible]

MAN HOURS - 2 Contd.

Site Number Lee's Ferry/Main Ferry Site
 Structure Number 4

Activity	Structural Location	North		East		South		West		General Structure	Tot
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
IV. Stabilization Activities											
A) Relaying		:15									:15
B) Newlaying		:05	:45	1:00	:05	:10	:10				2:15
C) Resetting											
D) Recoursing											
E) Wedging			:15	:10		:15					:40
F) Repointing											
G) Pointing											
H) Remudding											
I) Replastering											
J) Painting											
K) Texturing											
L) Curing											
M) Drainage contouring			:15	:15	:15						:45
N) Water Barrier Construction											
O) Backfilling											
P)											
Q)											
Q)											
V. Structure/Job Cleanup											
A) Removal of Stabilization Equipment											
B) Removal of Stabilization Debris											
C) Return Work Area to Natural Condition											
D) Graffiti Removal											
VI. Other											
Grand Total											
		:30	2:05	2:05	:45	:25:35	:10				6:35

STABILIZATION MATERIAL UTILIZATION
MORTAR/SEDIMENT QUANTITIES
(Cubic cm (cm³))

Site Number Lee's Ferry/Main Ferry Site
Structure Number 4

Structural Location		North		East		South		West		General Structure	Total
Activity		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
I. Mortar Quantities Used											
A) Relaying											
B) Newlaying											
C) Resetting											
D) Recoursing											
E) Repointing											
F) Pointing											
G) Remudding											
H) Replastering											
I) Painting											
II. Total											
III. Sediment Quantities Used											
A) Texturing											
B) Backfilling											
C) Drainage Contour		>	28380	14190	18920						61490
D) Cover features/ protect cultural material											
E) Trail work											
F) Roof coverage											
IV. Total											
V. Grand Total			28380	14190	18920						61490

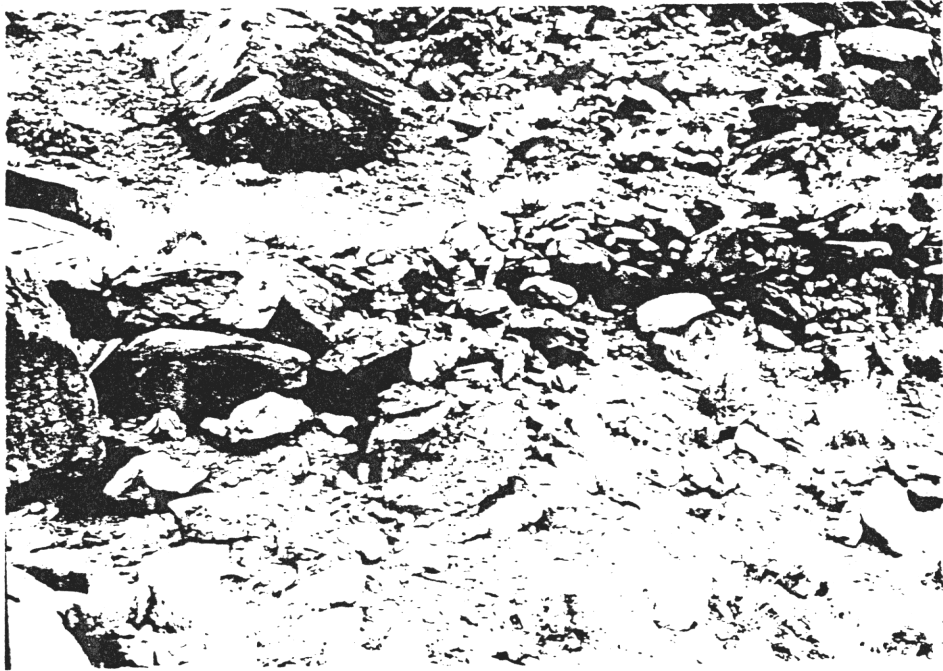
STABILIZATION MATERIAL UTILIZATION
STONE-MASONRY-QUANTITIES

Site Number Lee's Ferry/Main Ferry Site
Structure Number 4

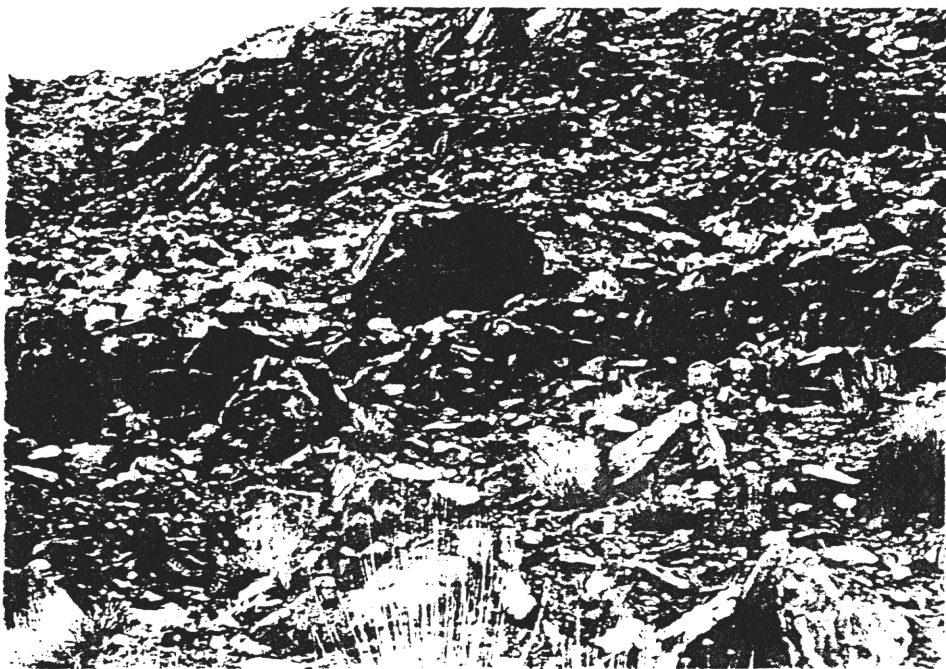
Activity	Structural Location	North		East		South		West		General Structure	Tot
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
Relaying											
Newlaying		X	X	X	X	X	X				
Resetting											
Recoursing											
Wedging			X	X		X					
Repointing											
Pointing											
Remudding											
Backfilling					X						
Stone Size											
Small			10	5	1						16
Medium			10	14	10		5				39
Large			2	3							5
Very Large				6	2						8
Spall Size											
Small											
Leveler			3			2	3				8
True											
False											
Medium											
Leveler											
True											
False											
Large											
Leveler											
True											
False											
Chunk Size											
Small											
Medium											
Large											
Total			25	28	13	2	8				76



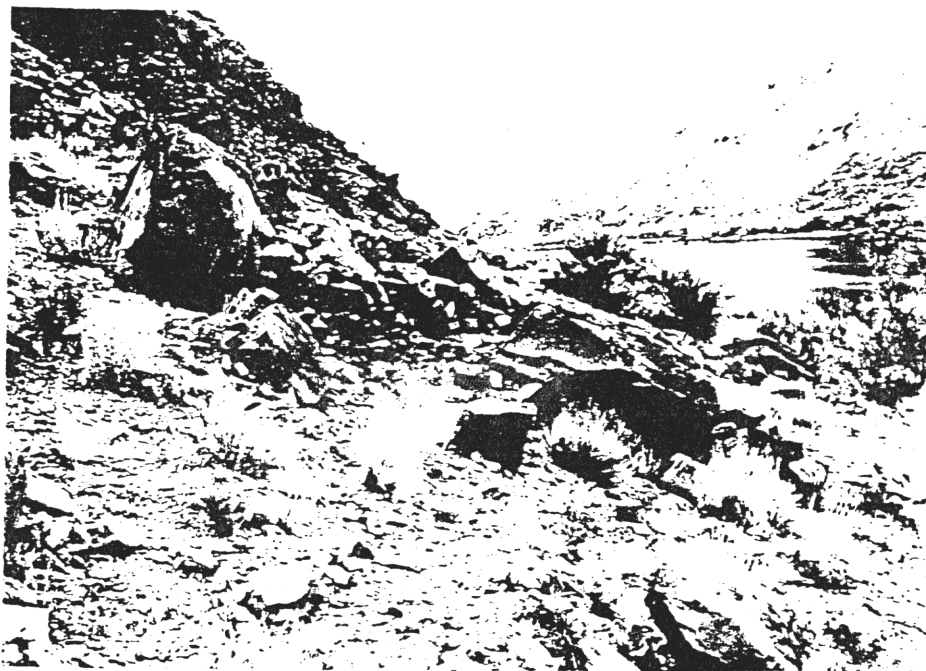
Structure 4, overview before stabilization.



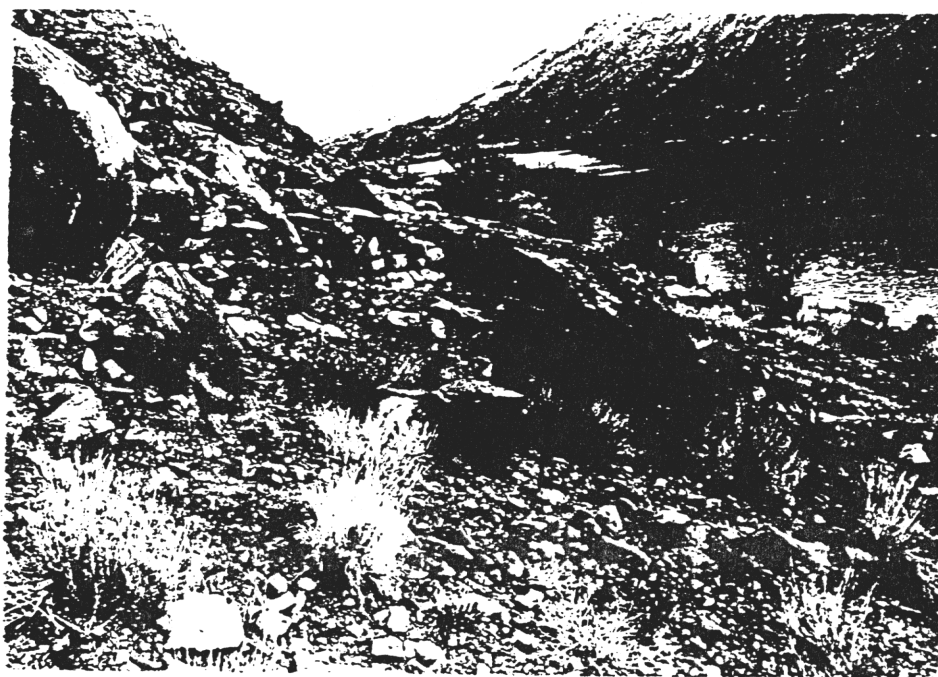
Structure 4, east wall interior, north portion, before stabilization.



Structure 4, east wall interior, north portion, after stabilization.



Structure 4, north wall exterior, east half, before stabilization.



Structure 4, north wall exterior, east half, after stabilization.

Lee's Ferry, Main Ferry Site



Structure 4, northeast exterior, after
drainage contouring.

STRUCTURE STABILIZATION DATA SHEET

Site Name/Number Lee's Ferry - Main Ferry Site Personnel JLM

Structure Number 5 Date Started 10/23/85
Date Finished 10/24/85

Structural Location

Description of Work Performed

North and South Walls: The interiors of these walls were wedged with stones to fill gaps and eliminate loose stones. A variety of stones was newlaid in the basal portion midsection and along both east and west wall ends of the north and south walls to provide support for the overhanging masonry. The exterior of the western wall ends, where they curved around to retain the sloping fill, were wedged and stone was newlaid under unsupported masonry, with care taken to position the stones so as to direct water away from the wall. Two large, tabular stones and some small and medium stones were newlaid in the trail area immediately west (in front) of the north wall to retain the unconsolidated fill along the sloping trail surface. Backfill sediments obtained from the drainage south of the structure were added to the trail along the front of the structure. Both stone and sediment were added to fill basal areas along the trail that had been undermined by both foot traffic and water runoff. This work should forestall future erosion in these areas.

SPECIFIC STRUCTURE/JOB

Personnel JM Date 10/24/85

[illegible]

MAN HOURS - 2 Contd.

Site Number Lee's Ferry/Main Ferry SiteStructure Number 5

Structural Location		North		East		South		West		General Structure	Tot
Activity		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
IV. Stabilization Activities											
A) Relaying			:10								:10
B) Newlaying		:45	:10			1:50	:20				2:20
C) Resetting											
D) Recoursing											:40
E) Wedging		:25				:15	:15				
F) Repointing											
G) Pointing											
H) Remudding											
I) Replastering											
J) Painting											
K) Texturing											
L) Curing											
M) Drainage contouring											
N) Water Barrier Construction											
O) Backfilling										1:00	1:00
P)											
Q)											
Q)											
V. Structure/Job Cleanup											
A) Removal of Stabilization Equipment											
B) Removal of Stabilization Debris											
C) Return Work Area to Natural Condition											
D) Graffiti Removal											
VI. Other											
Total											
		1:18	:25			1:13	:40			1:20	4:56

STABILIZATION MATERIAL UTILIZATION
MORTAR/SEDIMENT QUANTITIES
(Cubic cm (cm³))

Site Number Lee's Ferry/Main Ferry Site
Structure Number 5

[illegible]

STABILIZATION MATERIAL UTILIZATION STONE-MASONRY-QUANTITIES

Site Number Lee's Ferry/Main Ferry Site
Structure Number 5

Activity	North		East		South		West		General Struc- ture	Total
	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
Relaying		X								
Newlaying	X	X			X	X				
Resetting										
Recoursing										
Wedging	X				X	X				
Repointing										
Pointing										
Remudding										
Stone Size										
Small	13	10			6	2			3	34
Medium	4	6			9	4			2	25
Large	2				1	2			3	8
Very Large										
Spall Size										
Small										
Leveler										
True										
False										
Medium										
Leveler										
True										
False										
Large										
Leveler										
True										
False										
Chunk Size										
Small										
Medium										
Large										
Total	19	16			16	8			8	67

Lee's Ferry, Main Ferry Site



Structure 5, overview before stabilization.

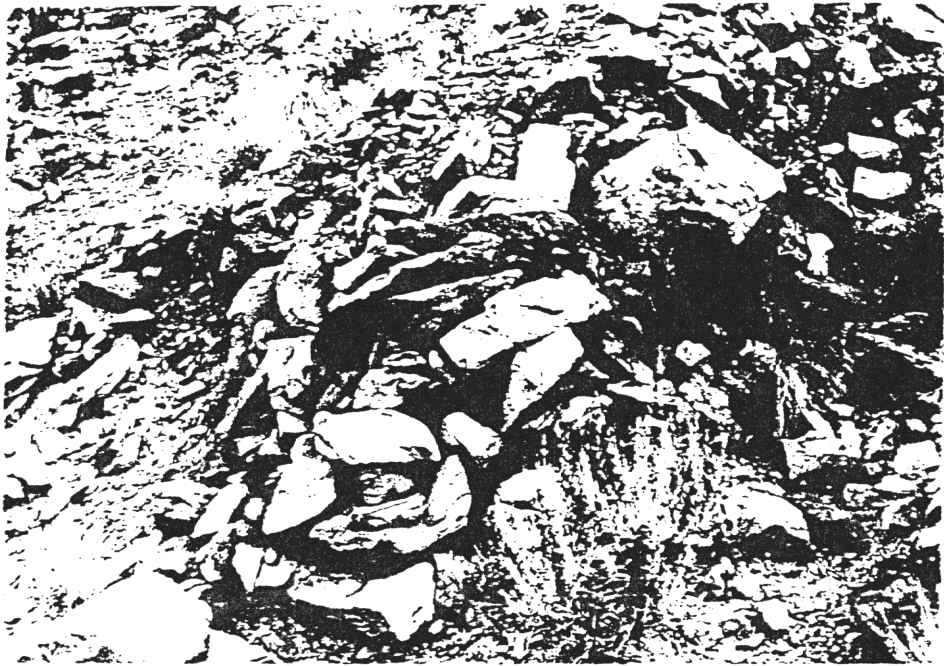


Structure 5, north wall interior before stabilization.



Structure 5, north wall interior after stabilization.

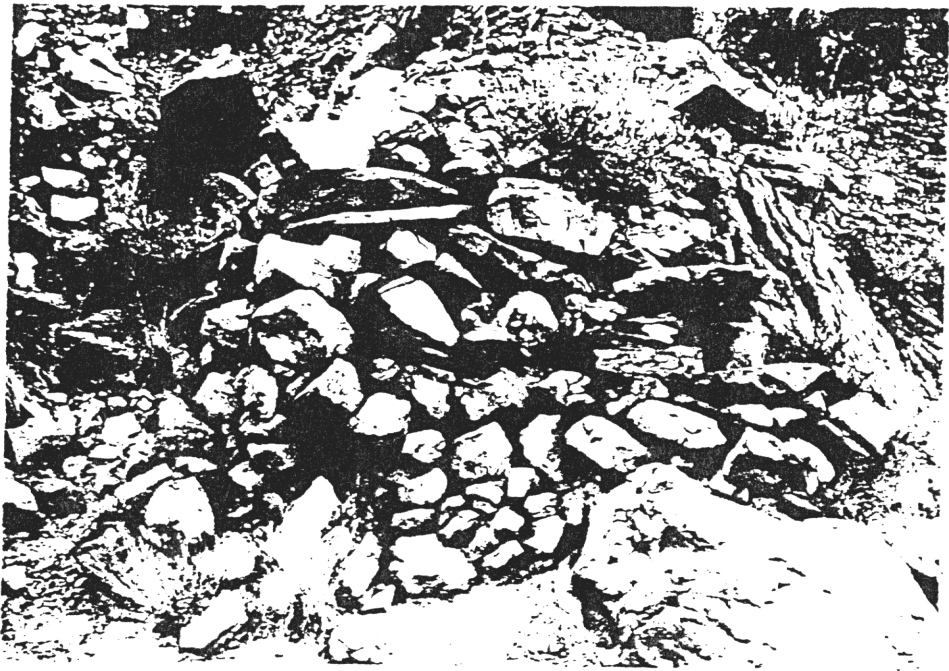
Lee's Ferry, Main Ferry Site



Structure 5, north wall, west end, before stabilization.



Structure 5, north wall, west end, after stabilization.



Structure 5, south wall, west end, before stabilization.



Structure 5, south wall, west end, after stabilization.

STRUCTURE STABILIZATION DATA SHEET

Site Name/Number Lee's Ferry - Main Ferry Site Personnel J. Horn

Structure Number 8 Date Started 10/31/85
Date Finished 10/31/85

Structural Location Description of Work Performed

Structure 8 was backfilled with sterile sediments to protect the remaining masonry and interior fill from the impacts of exposure and foot traffic. A layer of clean sand was placed within the depression then backfill sediments were added, filling but not obscuring the depression. Locally occurring soils were swept over the imported fill to blend it in with the surrounding area.

SPECIFIC STRUCTURE/JOB

Personnel JH Date 10/31/85

[illegible]

MAN HOURS - 2 Contd.

Site Number Lee's Ferry/Main Ferry Site
Structure Number 8

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
IV. Stabilization Activities											
A) Relaying											
B) Newlaying											
C) Resetting											
D) Recoursing											
E) Wedging											
F) Repointing											
G) Pointing											
H) Remudding											
I) Replastering											
J) Painting											
K) Texturing											
L) Curing											
M) Drainage contouring											
N) Water Barrier Construction											
O) Backfilling										:30	:30
P)											
Q)											
Q)											
V. Structure/Job Cleanup											
A) Removal of Stabilization Equipment											
B) Removal of Stabilization Debris											
C) Return Work Area to Natural Condition											
D) Graffiti Removal											
VI. Other											
Total											
										:35	:35

STABILIZATION MATERIAL UTILIZATION MORTAR/SEDIMENT QUANTITIES

(Cubic cm (cm^3))

Site no. Lee's Ferry/Main Ferry Site

Structure no. 8

Activity	Structural Location	North		East		South		West		General Structure	Total
		Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.		
I. Mortar Quantities Used											
A) Relaying											
B) Newlaying											
C) Resetting											
D) Recoursing											
E) Repointing											
F) Pointing											
G) Remudding											
H) Replastering											
I) Painting											
II. Total											
III. Sediment Quantities Used											
A) Texturing											
B) Backfilling										151360	151360
C) Drainage Contour											
D) Cover features/ protect cultural material											
E) Trail work											
F) Roof coverage											
IV. Total										151360	151360
V. Grand Total										151360	151360



Structure 8, overview before stabilization.



Structure 8, overview after stabilization.

THIS PAGE HAS BEEN FILMED IN PLACE OF DRAWING
OR MAP WHICH IS TOO BIG FOR 16mm MICROFICHE.
SEE 35mm MICROFICHE AT THE END OF REPORT.